Participatory approaches to work with adult basic mathematics students

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Abstract

The data collection for this ethnographically-based participant action research took place over a period of three years, in three organisations: a Further Education college, an LEA community education service and a voluntary sector community centre. Data is largely drawn from my own basic mathematics (numeracy) teaching in those centres. Numeracy students took part as co-researchers, examining the discourse of their own classes, organising a students' conference, interviewing each other and producing a magazine. Records from my own teaching file are also used, as are classroom transcripts.

My central research question was:

- How can I work to strengthen students' voices in adult basic maths education?

This includes a consideration of what it means to be a radical tutor in adult basic education. These questions are contextualised through a consideration of the major influences on my own adult education work over 25 years, particularly the writings of Paulo Freire and Antonio Gramsci and the development of adult literacy and numeracy education in London.

The thesis offers descriptions and analysis of several key episodes from the research, from the detail of students' work on subtraction algorithms to their findings at the students' conference. The analysis of the data is informed by the work of discourse analysts (e.g. James Paul Gee, Norman Fairclough) and problematises the notion of 'voice'. Central findings include:

- students reject the tendency of dominant discourses to generalise about adults' mathematical needs and ways of learning;

- positioning students as co-researchers changes the discourse of the maths classroom. This both leads to new insights into students' mathematical understandings and practices (inside and outside the class), and unsettles the power and authority relations between students and tutor/researcher.

The thesis offers evidence for approaches, some drawn from adult literacy work, which support such changes.

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From the bottom of my heart I thank all the students who took part in this research. They put up with endless taping, note-making, borrowing of their work and interruptions ('What was that? Say it again?'). They organised events, argued with me, agreed with me, asked me difficult questions and said things I didn't want to hear. I particularly want to thank Joyce Gray, Violet Kattah and Sandra Wilson, who long after their maths work with me had finished carried on debating the ideas in the thesis. They are all continuing in adult education and I wish them good luck in their studies.

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My fellow PhD students have helped me with the ideas, the computer, the proof-reading, the afternoon naps ... Thank you.

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Dedication

For Barbara Tomlin, who first suggested I should become a volunteer tutor in adult literacy education.

Abbreviations

ABE	Adult Basic Education
AE	Adult Education
AL	Adult literacy education
ALBSU	Adult Literacy and Basic Skills Unit
ALM	Adults Learning Mathematics
ALRA	Adult Literacy Resource Agency
ALU	Adult Literacy Unit
AN	Adult numeracy (adult basic maths) education
ANC	African National Congress
BSA	Basic Skills Agency
CDA	Critical discourse analysis
CR	Consciousness raising
DfEE	Department for Education and Employment
ENL	Empty number line
FE	Further Education
FEFC	Further Education Funding Council
ILEA	Inner London Education Authority
LEA	Local Education Authority
NFVLS (later NFVES)	National Federation of Voluntary Literacy Schemes (later National Federation of Voluntary Education Schemes)
NLS	New literacy studies
NSA	National Students' Association
PAR	Participant action research
PRA	Participatory rural appraisal
RaPAL	Research and Practice in Adult Literacy

Contents

Chapter 1: Introduction

When I started the research reported in this thesis, my questions were:

> *What are the functions of writing in basic maths classes for adults? How does writing contribute to strengthening students' voice? What are the implications for radical tutors?*

I assumed that writing would, in some way, strengthen students' voices (an assumption that came from my background in adult literacy work). As the research progressed, the data I was gathering made me realise that I needed to frame my research questions more broadly.

Firstly, I found that 'writing' could not be usefully analysed without considering wider discursive contexts and the practices behind the visible texts. This phase of the research was reported in an early paper, *Some difficulties in claims made for writing in mathematics education* (Appendix 1). Secondly, the notion of 'students' voice' became problematised. And thirdly, the data generated through students' involvement as co-researchers challenged my view of myself as a radical, or at least would-be radical, tutor. As the research continued the students and I generated new questions.

Chapter 2, *Contexts,* is based around my own background in adult literacy and adult numeracy education and the influences and ideologies that have contributed to the formulation of questions. The chapter concludes with a revised set of research questions to be addressed in the thesis:

1. *What does 'radical' mean in adult numeracy work, for me, in Britain, now?*
2. *Does this research fit a Gramscian or Freirean model, and if so, how?*
3. *What and how can tutors 'negotiate' in a government-funded numeracy course? How does negotiating the curriculum have a bearing on voice and empowerment?*
4. *What is the action in this research? In what sense is this research participatory?*
5. *What do pedagogic practices from literacy bring to the numeracy classroom?*
6. *Is there a necessary connection between tutors' and students' epistemologies of maths and classroom practices? How does students' own maths experience fit into a negotiated curriculum and into dominant, 'standard' maths?*

In Chapter 3 I describe the methodology employed in the research. I used ethnographic research tools within the frameworks described in Chapter 2: broadly, theories of adult literacy as 'empowerment', theories of critical education and discourse theory. I go on to discuss the nature of the study, in terms of participant action research, teacher research, a narrative containing other narratives, and 'telling' case studies (Mitchell, 1984). I explain my reasons for presenting the central part of the thesis as stories from the research, and discuss the possible effects of having to omit other stories. The stories included here have been selected both for their richness (each episode contributes to more than one research question and to the development of several themes) and their range and variety.

The stories are:

Chapter 4: *Paulette and Cindy discuss their maths diaries*	This interview between two students was important in changing the direction of the research. The notion of 'voice' is problematised; and Paulette and Cindy alerted me to epistemological and pedagogical issues I had not previously addressed.
Chapter 5: *Observing ourselves*	This chapter discusses the work of a group of students who observed their own classes, and the consequent 'unsettling' of classroom discourse.
Chapters 6: *Investigating the 100 grid,* 7: *How do you do maths?* and 8: *Students writing maths questions* all focus on the detail of maths work in the classroom.	These chapters explore the effects on classroom discourse and the research project of students' work as investigators and discourse analysts within maths. They include discussion of the importance of detail in discourse analysis and the range of communicative practices in maths classrooms.
Chapter 9: *Meeting for Maths Students for Beginners*	The *Meeting for Maths Students for Beginners* was a conference organised by and for students. The chapter focuses on the transformative effects of students' work as researchers, and on students' views of mathematics teaching, learning and curricula.
Chapter 10: *Global Maths*	*Global Maths* is a magazine which grew out of the conference and was produced by students. The chapter focuses on the writing practices involved in generating texts, and on analysis of the themes of students' writing.

Chapter 11 is organised around the themes I draw from the research, rather than around my research questions, to enable us to see something of students' take on the research, as well as my own. Students' participation as researchers led to research questions and data which would otherwise have been unavailable to me. I suggest that while students were 'participant', the 'action' of the research lies in the unsettling of the discourses of their own classrooms (question 4). This is a different sense of 'action research' and nearer to my 'democratic' interpretation of a 'radical agenda' (see below) than generally recognised. However, it leads to a new and unresolved question: how will basic education students be 'recognised' (Gee, 1999) as researchers?

The next group of themes reflects students' and classroom perspectives, including students' aims in maths, curricular and pedagogical issues. Here I find that there is no necessary connection between tutors' and students' epistemologies of mathematics and our classroom practices (question 6). I go on to discuss text-oriented discourse issues, classroom organisation and curriculum negotiation. Students' aims, ways of working and communicative practices are diverse, and I consider implications for pedagogy and negotiating the curriculum (question 3). I argue (building on evidence in chapters 4 – 10) that centring courses on students' own narratives (drawing on pedagogic practices from literacy, question 5) and analyses of their own and their group's work is a productive route for negotiating both the curriculum and the tutor's pedagogic stance (addressing question 3). Using students' narratives and analyses represents a move towards the kind of radical democratic and action orientation I am suggesting.

The third group, of wider themes, includes discussion of confidence as a measure of success, the unsafe (I argue) distinction between 'everyday' and academic mathematics, and unsettling classroom discourse. The three groups of themes are linked through an analysis of meaning in ABE maths – from the meaning of an algorithm to epistemologies of maths as a whole – as discursively constructed.

I then relate the themes back to the key concepts of voice and empowerment, and re-consider perspectives derived from Gramsci and Freire – 'radical heroes' of adult education (Coben, 1998c) - in the light of this research (addressing questions 1 and 2). I suggest that for tutors to use their position of authority in the classroom to promote their own view of a radical agenda is not an ethical or democratic use of their power. When students are positioned as researchers into the discourse of their classrooms, the discourse is unsettled and tutors and students can look on the project of developing democratic practices as a shared endeavour: it is this 'democratic' sense of the 'radical agenda' cited in question 1, linked to the original meaning of 'radical', 'from the root' (Coben, 1998c), rather than the more top-down sense of 'radical', that I am suggesting in this section.

Chapter 2: Contexts

1 Introduction

In this chapter I discuss the contexts, in my own background and in ideologies in adult education, which led to my research questions.

I set the thesis in a personal context by raising questions about what 'radical' may mean for me (section 2) and discussing the oral research tradition which has strongly influenced my positioning and practices as a tutor (section 3).

In section 4 on adult literacy (AL) education I start with the influences of the two 'radical heroes' of adult education (Coben, 1998c): Paulo Freire and Antonio Gramsci. I then go on to discuss the key concepts of *voice* and *empowerment*, through discussion of the early (1970s and '80s) literacy workers' mottoes 'build on students' strengths' and 'strengthen students' voices', the later problematisation of the notion of 'voice', and the development of two areas of theory and research, critical discourse analysis (Fairclough, 1989; Fairclough, 1995) and new literacy studies (Barton & Hamilton, 1996; Gee, 1996; Street, 1997b). I then discuss 'negotiating the curriculum', widely viewed as a key strategy for 'empowerment' within AE, and go on to outline participant action research (PAR), the dominant research paradigm in adult literacy in Britain. PAR (discussed in more detail in Chapter 3) is important both because the present research fits under its umbrella and because it may appear to fit a radical or democratic agenda. The section finishes with pointers to some strong challenges to 'critical' education and the notion of voice, drawn from poststructuralist and feminist educators.

In section 5 on adult numeracy education (AN), I start with an outline of the differences between 'early' (1970s and 80s) AN and AL educational practices, before going on to consider interconnected recent developments in numeracy theory and practice, which have impinged on my own teaching and research: situated cognition, ethnomathematics, new readings (particularly anti-racist) of maths history, life histories of maths and the developing use of discourse theory in adult education (AE). The section finishes with a return to Freire and his impact on maths education.

I hope that sections 4 & 5 will allow the reader to understand where I and many other radical adult basic education (ABE) workers are 'coming from' - the discourses that have formed our work and which we have helped to shape. Many of the students in the project too share this history: students with (in some cases) years of experience of basic education classes have commented on the differences in atmosphere and style between numeracy and literacy classes of particular tutors and education centres, reflecting I think the overlaps and gaps between strands of these histories.

My outline will note contradictions and disagreements about key issues. James Gee suggests a category 'conversations', which he defines as

> *the precipitates of what we will call ..."situated meanings" and "cultural models" as these have circulated with and across Discourses in history ... "Conversation" ...concentrates on themes and topics as they are "appropriately" "discussible" within and across Discourses at a particular time in history, across a particular historical period, within a given institution or set of them, or within a particular society or across several of them. (Gee, 1999: 37)*

Gee's 'conversations' between Discourses (in this case, the Discourses are Gramscian and Freirean, critical and postcritical, domesticating and emancipatory, for example) may involve controversy and 'sides' to arguments, with values and ways of thinking connected to the debates; this discussion of literacy and numeracy education is intended to clarify some of the controversy and commitment in concepts such as *voice* and *empowerment*, so the reader may understand the 'situatedness' as I try to work out what 'radical' educational practice may mean in the particular context to be discussed in this thesis. Throughout, I refer only to those writers, friends, theorists and practitioners whose work has directly influenced mine - so this chapter is not a 'history' of adult literacy and numeracy work.

In section 6 I set the immediate context for the research: a clash between current official discourses of adult numeracy and any attempt to be radical.

Key questions from these contexts - issues that worried me before and during the research - are listed at the end of the chapter; they return in Chapter 11.

2 A radical adult educator?

Diana Coben defines radical adult educators as

> *those who aspire to a progressive social and political purpose in their work, who want change in the original meaning of "radical", 'from the root.' (Coben, 1998c: 3)*

That describes me. There is a difficulty, however, as Coben points out: working out what the 'change' might be. Take 'empowering students' - an aim which I imagine all radical adult educators espouse. Do we mean they should be empowered in the classroom, or as part of national or international revolutionary change? Does the one depend on the other? If so, which comes first? What is the role of a tutor - leader, facilitator, co-worker? What, if any, is the relationship between these directly political questions and particular subjects in AE (numeracy, pensioners' discussion groups, clothes-making ...)? Is improving your numeracy of itself empowering? I ask these questions not because I propose to offer answers, but because they indicate some of the ambiguities and potential contradictions in the use of the word 'radical'. The difficulties of working out what 'radical' might mean in my own work led to my research questions.

My experiences as a literacy and numeracy tutor have formed the questions, and influenced my analysis and interpretations, throughout this research project. Many of the episodes I shall go on to describe identify moments at which my role in the project (for example my worksheets, my lesson planning, what I said, who I ignored, and so on) was clarified and criticised, by me and by the students. Initially in this research I set out to examine ways of 'strengthening students' voice' in AN education. I shall be outlining the key influences on my own practice - the influences which led to my concern with 'students' voice' and 'empowerment' (the 'scare quotes' reflect the way the project has problematised these concepts).

In Chapter 3 I present the research as 'telling' case studies of my own and students' work. Although my own case (and each student's) is in its detail unique, I am not at all unusual in that many ABE tutors would recognise the broad radical AE agenda, the discourses which form it and the questions which haunt it. Adult numeracy work in Britain developed after adult literacy education, which itself was established, in the 1970s, within a liberal AE tradition. I shall outline only the features of these traditions which have led directly to my own practice; this account, then, is my own 'take' on a history which nevertheless is shared.

3 An oral research tradition

First I point to those influences of which there is no, or scanty, written record. In the formative 1970s, when I started work as a literacy tutor, and early 80s literacy practitioners (students and tutors) did research *by mouth* and *in groups*. Many people have enormously influenced my own practice by discussing with me key incidents in their own teaching and learning and in mine. I recall key moments when I learned and changed tack; these are moments in political debate. Some were in informal discussion; some in conferences (including the National Federation of Voluntary Literacy (later Education) Schemes, the National Students' Association, organised by ABE students, and ALRA and its successor organisations); some in informal but organised discussion groups. Those moments came, too, in training courses, because the activists were also the organisers and the tutor trainers (including students: the voluntary scheme where I first worked was managed by a committee including students, and students came to training courses both as trainers and to learn how to teach each other).

Coben identifies the absence of students' voice from written theory:

> *[T]here is a constant danger of privileging the written, published form over the spoken and unspoken lived experience of adult educators and students. Often, exciting, innovative practice remains unknown to anyone outside the immediate circle of those engaged in it... The voice that is most rarely heard in debates about the politics and purposes of the education of adults is precisely that of the adult student. (Coben, 1998c: 6-7)*

There is an argument that because we (practitioners, including students and tutors, paid and unpaid) didn't write enough down, we weakened ourselves irretrievably and were unable to deal with the later 80s when cuts were augmented by the onslaught on local authorities and the 90s culture of accreditation. Nevertheless, the active criticism of each others' practice produced a climate of extraordinary political and cultural richness. Further, having these debates orally meant literacy students were less restricted by difficulties in reading written research.

We were engaged in research, if it means critical analysis of practice in a context of building theory. Some of what follows in this thesis is *stories* of what students and I have done; it's a written version of what was once the currency of research. Some of the accounts here are necessarily written in an academic register which is comparatively inaccessible to students; they have been re-written (or in some cases were first drafted) for a student readership. (For example, an article discussing some of the research (Tomlin, 1998) is I think more 'readable' than others in the same journal, because it had to be accessible to students.)

4 Adult Literacy

I will discuss here some key themes from adult literacy in the later 1970s and the 1980s, focusing on those which are relevant to the present work, either because they have informed practice in the sites in which the research was carried out, or because they have been incorporated, to greater or lesser extent, into debates about AN work.

4.1 Literacy work is political

Literacy work was identified as political, by practitioners and the government (Street, 1997a). Many literacy schemes worked in association with community development centres on overtly political (broadly left) projects (Jackson, 1995; Lovett, 1995; Yarnit, 1995). For example, literacy students at the community project at which I worked in the late 70s and early 80s included people who were actively involved in a local housing campaign, the community newspaper, and tenants' groups, all of which were in some way supported by the project (community politics in the South London area of this scheme is discussed by

Cockburn, 1977); themes for reading and writing work were often drawn from these campaigns, and from the history of the local area, including the history of settlement in the area. The community photography project offered free courses, from which students and workers together produced strip 'cartoons', using photographs and writing, ranging from fictional melodrama to campaigning materials. Similar work, broadly community-based and locally determined, is reflected for example in Coben, 1987, Frost & Hoy, 1985, and QueenSpark Rates Book Group, 1982.

The key political theorists invoked by radical adult educators were Paulo Freire (particularly Freire, 1972b), and Antonio Gramsci (particularly Gramsci, 1971). Key works by Freire became available in Britain in the 1970s and were often recommended to literacy tutors in training (particularly *Pedagogy of the Oppressed* (Freire, 1972b), and *Education: The Practice of Freedom* (Freire, 1976)). Little by Gramsci was available to British readers before the 1971 publication of *Selections from the Prison Notebooks* (Gramsci, 1971).

It is important that what was taken by AE practitioners from Freire and Gramsci was severely limited. Freire is comparatively 'easy' to read (once key new terms such as conscientization become familiar), but we read only those parts of Freire's work that seemed to 'fit': thus his theological writings were largely ignored, though in retrospect I would argue his theology saturates his writing on education. Gramsci is notoriously difficult to read; the prison notebooks were largely fragmentary and often to some extent coded, so that 'what he meant' is up for question. What I shall attempt here is a sketch only of the key ideas of both so far as they were adopted into the currency of AE. (For a study and comparison of the works of Freire and Gramsci in relation to AE see Coben, 1998c.)

4.2 Paulo Freire

Freirean concepts saturate much of the literature about radical or liberal AE, from texts specifically on teaching approaches to community politics (see for example Berggren, 1975; Kirkwood & Kirkwood, 1989; Mace, 1992; Mackie, 1980). Our discussions were focused on practice: crudely, on how to achieve 'empowerment' through teaching and learning. (Though the term 'teaching' was often avoided, as calling up the power relations of schools; many of us instead said we were 'working with students'.)

The key ideas taken from Freire centre around conscientization and the 'culture of silence'. Conscientization is a three stage process, in which people move from 'semi-intransitive consciousness' through a 'naive transitive' stage to 'critical transitivity'. The semi-intransitive stage is characterised by a culture of silence, in which people are unable to express their view of the world and therefore unable to act to achieve change; they are 'submerged in the historical process' and 'lack a sense of life on a more historic plane' (Freire, 1976: 17). Critical transitivity is characterised by

> *depth in the interpretation of problems; by the substitution of causal principles for magical explanations ..[It] is characteristic of authentically democratic regimes ... - in contrast to silence and inaction, in contrast to the rigid militarily authoritarian state presently prevailing in Brazil. (Freire, 1976: 18-19)*

This shows Freire's typical close association of the larger political sphere (in this case, the Brazilian state) and personal educational/political development.

The process of conscientization is central to Freire's pedagogy. Learning circles are based on dialogue focused on codifications (drawings) of key themes in learners' lives, those themes to be established by investigators whose work precedes the establishment of learning circles. Political change is to result from praxis, the combination of action and reflection on the world. 'Dialogue' is the basis of praxis and conscientization, though Freire's precise meaning is not always clear. It is more than talking or conversation:

> *Existence is a dynamic concept, implying eternal dialogue between man and man, between man and the world, between man and his Creator. It is this dialogue which makes of man an historical being. (Freire, 1976: 17-18)*

There were many doubts among British adult educators about whether Freirean approaches were applicable in our context. However, one strand of Freire's thought has been held constant: that learners are entitled to, and benefit from, learning materials which are relevant to their lives. The question of who defines 'relevant' stands; but in the 1970s some literacy schemes were using children's 'readers' such as *Janet and John*, and Freire made the case against the use of such nonsensical texts. For example a sample list of 'generative' words includes slum, bicycle, work, food, government, sugar mill and wealth (Freire, 1976), and he specifically challenges a Portuguese language equivalent of Janet and John (Freire, 1985). This doesn't feel so important now, since literacy work has moved on; but the discussion of 'relevance' runs through this thesis, particularly in discussions of 'real world' and 'academic' maths.

One technical problem in Freirean approaches discussed by British educators was that the syllabic methods used in Portuguese are difficult if not impossible to apply in English. Debates over the broader issues included the question of a 'culture of silence'. While it was clear that in general working class people had little or no access to getting their words in print, to suggest people were silent contradicted common sense and assumed a deficit model. A strong theme in AL work has been 'strengthening students' voice'; but it was assumed that while students did not have access to print (publishing of students' writing will be discussed below), they did have a 'voice' in oral debate, and indeed another slogan was 'build on strengths', one of those strengths being spoken language. A related issue was Freire's focus on the development of reading skills, apparently to the exclusion of writing skills (judging by later works, writing is a key part of dialogue (Shor & Freire, 1987), but it follows the development of the technical decoding skills of reading, whereas literacy tutors in Britain were using students' dictated texts as material for both reading and writing).

Freirean ideas are still central to the thinking of radical adult educators. In his own lifetime Freire attained a mythic status:

> *Freire seems to offer a noble vision of adult education as politically liberating and spiritually redemptive, shot through with poetic insights, imbued with hope and crowned with love. Not surprisingly, he is regarded as ... of huge symbolic importance to a marginalized and underresourced field. (Coben, 1998c: 205)*

Freire has been the target of criticism, particularly from post-structuralists and feminists; some of those criticisms will be discussed below. The central critique has been that he undertheorises power and tends to ignore power relations among 'oppressed' groups and between tutor and learners. Freire and Freireans responded to some of the criticism levelled at his pedagogy and politics, and his later work accords more place to difference and to pedagogical power issues (hooks, 1994; McLaren & Lankshear, 1994; Shor & Freire, 1987; Taylor, 1997).

Despite challenges to a 'critical' education stance, and specific critiques of Freire, his name continues to have an 'emblematic' (Coben, 1998c) function in AL theory. For example, a USA typology of AL programmes claims to be based on Freire:

> *[Programs were categorised using] two specific dimensions of literacy practice based on the thinking of Paulo Freire...: life-contextualized/decontextualized and dialogic/monologic. ... [In the dialogic category] students are involved in all aspects of the program, serve on boards, and make decisions related to class rules; [in the monologic category] .. course content, activities and materials are all determined by the teacher. (Purcell-Gates, 1998)*

Researchers found that 'most programs clustered in the middle ... with very few extremes' (ibid.). It seems then that the dimensions were not helpful in characterising literacy programmes or classes. They do not, in my reading, relate very closely to Freire's own writing (he does not, as far as I know, discuss students' involvement in management). The researchers are to produce a 'teacher's manual'; this suggests that despite Freirean claims of 'empowerment', those expected to put theory into practice are teachers, not students (or indeed student managers).

4.3 Antonio Gramsci

The key ideas radical ABE educators took from Gramsci were 'hegemony' and 'organic intellectual'.

The hegemony of a dominant group works through incorporating subordinate groups; crucially, it works through the dominant group presenting its interests as though they were universal, so that they are adopted across a society and are given active consent (Gramsci, 1971: 244). Hegemony works through shifting alliances with different groups in the society, and to maintain hegemony the state is active in education and other cultural and legal fields. This means that the boundaries between 'the state' and the rest of civil society are not clear cut. Compared to Freire's mention of the rigid militarily authoritarian state of Brazil, quoted above, we can see that Gramsci's analysis 'fits' the democratic Britain of the 1970s and '80s in which Thatcher was voted into power and in which radical ABE workers wanted to make a contribution to a shift in the hegemonic order.

For Gramsci,

> *All men are intellectuals, ... but not all men have in society the social function of intellectuals. (Gramsci, 1971: 9)*

Gramsci divided people who had the social function of intellectual into two groups, organic and traditional; the former work on behalf of their class, in educational and organisational functions, and are the organisers of hegemony (Coben, 1998c: 19). When the *Selections from the Prison Notebooks* (Gramsci, 1971) were discussed among literacy workers in London we pondered whether it was reasonable to describe our work as developing organic intellectuals - but also whether we were ourselves organic intellectuals, that is, whether we were working towards change on behalf of the groups with whom we allied ourselves. The task of organic intellectuals for Gramsci was to work for the hegemony of their class over society as a whole - to achieve revolutionary change. Gramsci's analysis of the role of intellectuals, and rejection of the notion of intellectual as a static, non-activist, function, offered a way to see students and tutors working together on the same project.

Gramsci's attraction lies in his analysis of power in terms of hegemony and in his view of intellectual, including cultural and educational, work having a central function in gaining hegemonic change. Hegemony is not a static condition, but is always contested; and the constant contestation and change necessarily involve educational processes.

There is a particular interest for literacy workers in Gramsci's views of language. Since literacy students are (given differential education patterns) usually working class, they usually speak 'non-standard' varieties of English. Gramsci wrote that

> *Someone who only speaks dialect, or understands the standard language incompletely, necessarily has an intuition of the world which is more or less limited and provincial, which is fossilised and anachronistic in relation to the major currents of thought which dominate world history. (Gramsci, 1971: 325)*

Culture unifies groups of people; hence the question of 'collectively attaining a single cultural "climate"' (Gramsci, 1971: 349) is centrally important (Mayo, 1994).

This appears to run contrary to demands in British literacy work for the use of students' own language and the celebration of varieties of English, rather than constraining everyone into writing only in 'standard' English. I don't think however that there is a serious contradiction. The social construction of some languages as more powerful than others is a theme running through radical and liberal literacy education; we would now argue that being aware of this is part of 'the consciousness of what one really is' (ibid.: 324). Gramsci noted that printed matter was the largest part of the material used to maintain hegemony (Coben, 1998c: 22); radical adult educators could claim our work in student publishing as a contribution to a shift in the hegemonic order. We argued that the publication of students' work, in 'their own language' (critiques of this notion will be outlined below), was politically and culturally important, to all of us, not just the writers (though arguably print media are now less important than broadcast media). Further, valuing 'other' varieties of English is seen as a necessary step in gaining standard English literacy skills; there is no suggestion that gaining access to standard English is reactionary.

Diana Coben has analysed two important contradictions inherent in these debates: firstly, that Freire and Gramsci have crucially different politics, rendering the adoption of both together a poorly-founded enterprise; and secondly that adult educators' adoption of them as 'heroes' contradicts a democratic stance. She suggests that they

> *seemed to fill a need for radical left theory of the education of adults ... in a period when broad left alliances seemed to offer a way forward (Coben, 1998c: 201).*

She tracks in some detail the (often inaccurate) claiming in AE of Gramsci and/or Freire. My notes about the two cannot reflect the range of their educational theories and politics; what is important for the discussions in this thesis is that conscientization and the culture of silence, and hegemony and organic intellectuals, form the backdrop against which other key themes, to be discussed below, are seen.

4.4 Building on students' strengths and experience: consciousness raising

'Build on students' strengths' was a motto current in early literacy training and still in use today. One of those strengths was seen to be spoken language, to be discussed below. Here I look at parallels with consciousness raising; this is important to consider because it is sometimes conflated with Freire's conscientization. One of the contradictions in the adoption of Freire was his view of the 'culture of silence' of students. Many of the literacy trainers were feminists with experience of political theory and organisation in the women's liberation movement ('second wave', 1970s) (Thompson, 1995). 'Consciousness-raising groups' sought to build their own theory out of examination of their and other women's own experience. In common with those political groups, the basic education work I discuss here relied on group solidarity and students' willingness to learn from each other; it was organised in small groups which sometimes met together to share experience; it assumed that 'failure' had, by and large, a socio-economic rather than individual origin; and it was optimistic.

Kenway & Modra (1992) argue Freire's 'conscientization' is a more politically productive and action-oriented model than consciousness-raising. Similarly, Magda Lewis, in describing women students organising a women-only discussion about a male-dominated classroom, writes:

> *[W]hat happened to the women in this class was not just consciousness-raising - as important as that is - but, more important, it was a moment of politicization. This always implies collective action and ... such action is always revolutionary and difficult. (Lewis & Simon, 1986: 465)*

Wendy Ball links critical research methodology with Freire and feminist consciousness-raising:

> *The use of feminist consciousness-raising techniques [is] a central feature of research methodology... This links into Freire's notion of 'conscientization' whereby research participants are encouraged to recognise their oppression and to take collective, political action as a result. (Ball, 1002: 12)*

In my experience consciousness-raising groups in the British women's liberation movement in the '70s and '80s were a form of political organising which purported to be leaderless and which generated both theory and action - see for example Sue Bruley (1981), who describes the organisation of a consciousness-raising group, and Belfast Women's Collective (1981), who (in a highly politicised context) describe consciousness-raising as 'the basics'; by contrast, Freire's conscientization is based on a strictly hierarchical model of knowledge, and is not explicitly related to political organisation.

In feminist consciousness-raising the 'experience' being built on is not all in the past; it is not dead history. It includes analysis of the experience of the group itself. Thus Jane Lawrence's report of research into group work directly addresses students and tutors, inviting them to continue the research:

> *This book is for you, students and tutors, especially if you work in groups. ... As it stands, none of it was written for beginning readers, but there is no reason why*

> *parts of it should not be simplified or read aloud to people who find it too hard as it is. .. The Questions for Groups ... are there to help start things off. They should be replaced or adapted or added to, to suit you in your group. (Lawrence, 1985: 9)*

Such ways of sharing experiences across groups have informed my own practice in this research project, so that, for example, work by students in one group was discussed and further developed in other groups.

For me, consciousness-raising and politicisation are not in contrast to each other. These differences in our understanding are I think symptomatic of difficulties around the meanings of terms such as 'radical', 'critical', 'democratic' and 'action'. Their meanings shift with their political discourse - poststructuralist, feminist, Freirean, Gramscian, 'Old Left', critical, and so on - that is, they have 'situated meanings' (Gee, 1999).

4.5 Strengthening students' voice

'Building on students' experience' included reading and writing around personal histories and experiences; work on current affairs; and work on local and cultural history. Central to this is a focus on spoken language as a strength rather than 'illiteracy' as a weakness (Frost & Hoy, 1985; Mace, 1992). 'Voice' has been a hold-all for 'power', both in valuing students' language as a challenge to the 'functional literacy' model (Maguire et al., quoted below) and in control over learning; the latter is discussed in section 4.6.

Concern to strengthen students' voice in terms of valuing students' language was a factor in the publication of students' writing (another was the dearth of usable commercially produced texts). Several literacy schemes were associated with community publishing projects (for example, Centerprise, in Hackney, and Peckham Bookplace); others duplicated their own publications for smaller-scale publication (Duffin, 1995; Kyriacou, 1995; Mace, 1995; O'Rourke, 1995; Schwab, 1994; Schwab & Stone, 1985; Street, 1997a; Sunderland, 1995). Maguire et al. summarise these developments:

> *Turning people's speech into reading matter and showing that spoken language can exist as written language represented a crucial advance in method which led us toward publication of students' work ... It became clear that this was a radical alternative to concepts of functional literacy that not only limited the uses of literacy to those that met bureaucratic requirements, but continued to rule invalid and inadequate the language in which working-class people express, organise and present their lives and understanding. (Maguire et al., 1982: 126)*

The publication of students' writing has been carried into adult numeracy work, for example through the *Take Away Times*, an A3 free sheet from ILEA (Colwell, 1988) and the magazine *Global Maths*, a product of this research project (Chapter 10).

4.5.1 Problematising voice

'Valuing students' own language' has turned out to be more complicated than literacy workers initially understood. 'Turning people's speech into reading matter', as Maguire et al. put it, involves choices and issues of control at every level: whether to scribe 'ain't', 'isn't' or 'is not'; what to do about pauses and repetitions; what questions to ask; how to order the draft; at what level any publication should be (the group? the scheme? a book?) (Mace, 1996; Moss, 1995). Challenges to our practice came both from students and from practitioners. For example, William Brown gives two pieces of writing: the one his tutor wrote, supposedly based on what William said but barely identifiable, and his own account of farming (Brown, 1985); the ILEA Afro-Caribbean Project produced learning materials to support the exploration of the history of Creoles, standard and other varieties of English, against a background of valuing students' language histories and acknowledgement of the power differentials played out through language use (Harris & Savitzky, 1988; ILEA Afro-Caribbean Language and Literacy Project in Further and Adult Education, 1990; Schwab, 1994; Schwab & Stone, 1985). Thus the notion of 'students' own language' as a fixed and innocent form of speech with straightforward translation into the written word has been problematised.

4.5.2 Critical discourse analysis

More recently, practitioners have begun exploring using elements of critical discourse analysis (CDA) in literacy teaching (Fairclough, 1989; Fairclough, 1995; Lawrence & Jessop, 1997). CDA seems now to 'carry' what in the '70s and '80s was a more overtly political strand of AL theory; it is based in a view of literacy that sees it as situated, both constituting and constituted by power relationships. Although the tools for detailed analysis, framed in a particular theory, offered by CDA are comparatively new, the notion of picking texts apart to see how they position people is not. So for example a student with whom I worked around 1980 wrote an article for the community paper, challenging the readers (assumed to be 'alternative' community workers and local planning activists) *Was you born with a silver spoon in your mouth?* The paper received more letters than ever before, all challenging the grammar; the resulting discussions in the literacy scheme focused on 'good grammar' as a front for challenges to the content, which was an attack on what the student saw (and readers evidently recognised the attack) as middle class people trying to run local campaigns. CDA offers tools for such analysis; in Gramscian terms, it helps us analyse how texts support hegemony:

> *literacy has been used ... to solidify the social hierarchy ..., and ensure that people lower on the hierarchy accept the values, norms, and beliefs of the elites, even*

> *when it is not in their self-interest or group interest to do so. (Gee, 1996: 36, citing Gramsci, 1971)*

CDA will be discussed more fully in the following chapter, on *Methodology*.

4.5.3 The New Literacy Studies

Following Brian Street's strong critique of the autonomous model of literacy (Street, 1984) in which literacy of itself empowers the possessor, the 'New Literacy Studies' (NLS) (Barton & Hamilton, 1996; Freebody, 1998a; Kress, 1989; Street, 1997b), based on using ethnographic approaches to examine literacy practices, are beginning to influence research within AL groups (Black & Thorp, 1997; Fitzpatrick & Mace, 1996; Janks & Ivanic, 1992). NLS has focused primarily on the practices behind the production of texts - that is, what 'situatedness' means in practice. Thus Grenko & Fitzpatrick, (1994), for example, describe the histories, both separate and joint, of Fitzpatrick's work as editor on Grenko's book and relate the book to its potential readership (the publishers sell largely to literacy schemes) and to their own individual experiences, with implications for the tutor/editor and writer relationship.

Both CDA and NLS support adult literacy education's discourse of 'strengthening students' voice'. Indeed,

> *Schools ... ought to be about people reflecting on and critiquing the 'Discourse maps' of their society, and indeed, the wider world ... The exclusion of certain students' Discourses from the classroom seriously cheats and damages everyone ...Should you choose not to adopt this moral stance, then I, and others, like the non-mainstream people we have studied in this book, reserve the right to actively resist you and the ways in which your unreflective performances limit our humanity.... [There is an obligation] to continue to do linguistics as I have defined it in this book - it is a moral matter and can change the world. (Gee, 1996: 191)*

The change in the world is presumably at least at small group/community level. But Gee's references to Gramsci relate discourse analysis to changes in hegemony. CDA and NLS thus have in common with the consciousness raising of feminism a view of political change supported by small scale, detailed discussions rooted in lived experience.

Some of these developments in literacy (discourse analysis and discussion of genre, for example) have more recent parallels in mathematics education (section 5 below).

4.6 Empowerment within educational organisations

Along with valuing students' language the second broad meaning of 'voice' in literacy debates is a political voice (parallel to 'giving pensioners a voice', for example). Although many practitioners would (like Gee) hope that their work could contribute to broad changes in society, here I am concerned with the discourse of student 'empowerment' within the institutions and discourses of literacy education. The research discussed in this thesis absolutely depended on students as active participants. In this the work built on previous work within literacy, including students working as members of management committees, trainers and organisers, as well as the use of their published work on literacy as reading material for others. A good example is the work of Pecket Well, an independent college largely run by students (Hamilton, 1998), whose members have made influential contributions to conferences of students and other practitioners.

It is important to avoid idealising 'students' involvement', and particularly so when a liberal or radical left tradition is under threat so that we may hanker after a mythical lost garden of equality. The notion of equal power-sharing with students has been problematised in the present research - but that demonstration has come from students' interventions. This itself has precedents. For example, the National Federation of Voluntary Literacy Schemes organised a conference for students and tutors, looking at ways in which students could take more 'leading roles' in the work of their scheme. The report avoids self-congratulation; participants were critical of the conference and of some approaches to the discussions (NFVLS, 1981).

4.7 Student involvement: negotiating the curriculum

The term 'student involvement' reflects a critique of students' 'non-involvement' - that is, of AE discourses in which students are positioned as passive recipients of knowledge (Freire's 'banking' model (Freire, 1972b), which he contrasts with his own problem-posing model).

One central strand of student involvement, 'negotiating the curriculum', has become a standard part of 'good practice' in AE as a whole, though its interpretation and implementation are very varied. Its adoption into mainstream AE (Jarvis, 1995) suggests that it is not necessarily tied to a Freirean agenda; indeed, it is included in the part-time tutors' contract in some Further Education colleges. Here however I want to consider 'negotiating the curriculum' against an overtly political view of literacy. This ranges from negotiating with communities to plan the overall AE programme, to designing particular courses around the interests and experience of the students in the group. To show the range of possible meanings I give five examples below, from shared control of funding to negotiating courses with students under the draft national Adult Basic Skills Curriculum.

One of the limitations to negotiating the curriculum is that most funding is very closely tied to preset outcomes, and therefore funding to some extent determines curricula. Gurnah (1997) makes specific proposals for change in the government's funding methodology, to put 25% into the control of a partnership between the voluntary sector and the state sector; this was exactly the practice of an area of an LEA adult education service in which I was local manager in the early 1990s. Since this LEA (unusually) still directly funded AE courses (in addition to organising government-funded courses) the neighbourhood community education group, made up of representatives of community organisations, was able to lobby for additional funding as well as having control over allocation of a quarter of existing funding.

Kirkwood & Kirkwood describe the practical application of Freirean approaches across an AE programme. A Fresh Start programme, including psychology, politics, maths and creative writing,

> *involved the adaptation of the [Freirean] decoding process as a method of negotiating the curriculum with participants and briefing the specialist tutors. (Kirkwood & Kirkwood, 1989: 24)*

Here we don't know what is included in 'the curriculum'. It could include the overall programme (for example maths), the topics (multiplication, or a survey of local maths in use in the community, or women mathematicians), the pedagogy and any particular participants' aims. This example illustrates the adoption of 'negotiating the curriculum' into AE discourse, with an assumption, not always justified, that the phrase has an established meaning.

Grayson describes

> *"negotiating the curriculum" of courses by use of outreach tutor organisers from [Northern] College to work in meetings and community-based sessions to write draft course outlines with community activists....[and] "Do It Yourself" training courses (perhaps the equivalent of conventional Training the Trainers courses) to build in control of programmes with activists. (Grayson, 1995: 223-4)*

This project also developed a 'participative accreditation' model (ibid.: 225).

The first three examples have been at the level of negotiating programmes (and possibly pedagogy, though that is less clear). This model of sharing the planning and control of resource use is reflected also within courses' curricula. Indeed, much literacy work until the 1990s barely fitted the notion of a 'course', with its implications of an overall pre-planned shape. A typical slogan was 'Start where people are at'.

The fourth example comes from Martin Yarnit, who describes work on Merseyside in a Second Chance programme:

> *Each student wrote a brief account of their life, with a focus on their school history. From these accounts was drawn out a series of themes ... (Yarnit, 1995: 71).*

This approach is still in use and probably influenced the use of personal language and (later) mathematics histories in literacy (Harris & Savitzky, 1988) and mathematics education; it reflects, I would argue, links between feminist organisation in the 1970s and AE practice, through the aim of building theory from the shared experience of a group.

The new Adult Basic Skills Curriculum specifies 'generic' skills:

> *The skills that adults need are not fundamentally different from the skills that children need to learn. What is different is the* contexts *[original emphasis] in which adults use these skills and the widely different past experiences that they bring to their learning ... Each individual learner will come with their own set of priorities and requirements, and these must be the starting point of their learning programme development. (DfEE and Basic Skills Agency, 2000: Section 2.)*

The most striking differences between this and the examples above are firstly the basic skills/context split, and secondly the emphasis on the individual. The first four examples all imply that 'content' (now 'skills and knowledge' (DfEE, op. cit.)) is negotiable, and indeed is determined by the experience brought by the potential students and their organisations. The first four examples all, too, aim to work at group level (Yarnit starts from individuals but the aim is to uncover shared themes). For the DfEE the skills are non-negotiable and the task is to find appropriate contexts. The DfEE seems to assume students may lack the skills or confidence to negotiate their curriculum effectively. The process of 'bringing skills and context ... together' involves

> *engaging and involving the learner in the process of becoming increasingly autonomous. (ibid.)*

The outline course and lesson plans do not help a tutor trying to make the leap from individually negotiated learning plans to how to organise a course or lesson, since examples all relate to courses which already have a core subject (e.g. horticulture) which will be shared by all students (DfEE op. cit. Section 6).

My own work practices and beliefs were built in a tradition closer to that of the first four examples above, but the research took place at a time in which the FEFC funding arrangements were already strongly influencing curricula, particularly through the demand for formal accreditation of students' work.

4.8 Participant Action Research

The dominant modes of research in AL education have been action research and participant action research (PAR); the latter includes PAR as a vehicle for literacy education itself, as well as a means of researching literacy education. PAR has been advocated as Gramscian (Mayo, 1995) and Freirean (discussed below).

'Action research' was the primary research model of the funding agencies, ALRA and its successors, ALU and ALBSU (though they also produced quantitative research to demonstrate 'need') (cf. Street, 1997a). All 'pump-primed' their priority areas of work, typically funding a project development worker/researcher whose job was to develop and evaluate new work; results were disseminated at conferences of practitioners. Involvement of students as researchers was not required, but project workers had considerable autonomy and many based their evaluations on students' input (I write this from experience as a worker in ALRA and ALBSU projects). Usher & Bryant summarise the attraction of action research for a field which claims empowerment of students:

> *The promissory character of action research which is attractive to the adult educator is that it offers a mode of inquiry and understanding in which the conventional distinctions between teacher and taught, researcher and researched, are dissolved. Understanding is to be achieved through an emphasis on participative and collaborative procedures. (Usher & Bryant, 1989: 118)*

The Basic Skills Agency (successor to ALRA etc) has now moved away from action research (Hamilton, 1998), while PAR remains important in the discourses of practitioners.

PAR is described by Merrifield as having three defining ideas:

- participation: 'research should be owned and controlled not by researchers but by people ... who need the research to act on issues that concern them';
- action: it is defined by the need for action, which gives a need for the research and a yardstick for measuring how useful the research is;
- knowledge: 'Participatory researchers ... affirm "that people's own knowledge is valuable ... [they] regard people as agents rather than objects, capable of analyzing their own situations and designing their own solutions" (Merrifeld, 1997, citing Maguire, 1996: 32).

Recent UK literacy PAR projects include literacy students engaged in a form of the 'new literacy studies' discussed above: the study of literacy practices in their social context, using ethnographic methods. Thus Keen describes a family literacy project in which students researched their own literacy environment (Keen, 1995) and Lawrence and Jessop describe a literacy/photography project in which students researched local images, using techniques from critical discourse analysis, and produced their own (Lawrence & Jessop, 1997). In these two examples, the reading and writing 'content' of the literacy courses was drawn from the research; the research is itself the context for the teaching and learning of literacy skills. Elsewhere, students have worked with researchers to critically examine their learning centres (O'Mahony & Moss, 1996; Open Learning in Adult Basic Education Research Team, Bergin, O'Mahony, Hamilton, & Moss, April 1996).

PAR seems then to offer exemplars of 'giving students a voice' and 'empowerment'. However, I want to raise a problem: what is the 'action' in Merrifield's list of three defining ideas? Merrifield's phrasing ('the need for action') suggests that the action is a response to a problem of some sort. None of the examples of PAR given above involves 'an action' in the sense of a movement towards political change (although all, particularly the last, could be used by institutions as an impetus towards change). What they do suggest, at least potentially, is a move towards what might be called 'meta-knowledge' of the discourse of AL education, or critical discourse analysis (in this context it might once have been called 'consciousness-raising' about literacy). In contrast, much closer to Merrifield's definition are student campaigns to save their education centre (McDuffus, Sharp, & Nolan, 1997).

As 'action' is difficult to define, so is 'literacy'. The new literacy studies and critical discourse theorists have led us to challenge definitions of literacy which are divorced from particular social contexts and/or which separate literacy from spoken language (Barton, 1994; Gee, 1996). Further, educators influenced by Freire may see literacy education itself as a form of (political) action.

Merrifield's examples of PAR include work with a community organisation which challenged toxic waste dumping. Here although the 'action' is clear the 'literacy' is less so:

> *It was my first experience of the literacy of reading both the "word" and the "world."... Their own knowledge gave the official knowledge meaning.*
> *This is literacy work, if we interpret literacy as not just the technical ability to read and write, but the use of these skills in daily life to solve problems and make a better world. (Merrifield, 1997)*

It is of course literacy work, in the sense of using the skills of reading and writing. It is also, however (judging from Merrifield's description), community activism, a more useful (I would argue) umbrella term which can include literacy work along with driving around, making phone calls, calling and addressing meetings, debating strategy, staging protests and so on. Adult literacy workers are from a tradition which leads us to *want* our work to be political - not just in the recognition that all education is never neutral, but in making changes in bigger political structures. When we see something that *is* making changes, as the toxic waste campaign did, we want to claim it for the literacy fold; and that claim is made easier by the NLS and CDA wider definitions of literacy.

Related to PAR is the work of Reflect and other projects broadly grouped as Participatory Rural Appraisal. Reflect stands for 'Regenerated Freirean Literacy through Empowering Community Techniques' (Archer & Cottingham, 1996; Foroni & Newman, 1998; Newman, 1998); the *regeneration* involves considerable differences from Freire's original model. For example, the graphics (Freire's 'codifications'), which form objects of study and discussion, are produced by participants rather than by Freirean 'investigators', and the projects place emphasis on writing as well as reading (so there is no implication that participants have a 'culture of silence'). Above all, the move from Freire can be seen in the Reflect argument that literacy of itself does not empower people (cf. Coben (1998c) for a discussion of the uses of Gramsci in PRA).

Diana Coben (1998c) notes that Freire's method is adaptable to right wing purposes, and I would argue that PAR and PRA too have no necessary connection to democratic agendas. This is illustrated by The World Bank Institute's Participation Sourcebook. At the time of writing the World Bank is the object of international anti-capitalist agitation and demonstrations, yet Freirean rhetoric, and perhaps practice too, is housed within a key organisation of global capitalism. The *Sourcebook* writers explain that when they started,

> *we assumed we would be writing about "popular" participation, that is, participation of the poor and others who are disadvantaged in terms of wealth, education, ethnicity, or gender. (World Bank, 1996)*

They have moved from that position to 'stakeholder participation', where stakeholders include the World Bank itself. So PAR and PRA are not necessarily radical or critical methodologies.

4.9 Critiques of voice and empowerment

I want now briefly to indicate some strong critiques of the *voice* and *empowerment* themes, which come from poststructuralist and 'post-critical' (Lather, 1992: 131) directions. These critiques are linked to a challenge both to Freirean perspectives, and to the work of 'critical' education theorists such as Giroux (e.g. Giroux, 1981). Broadly speaking, poststructuralists argue that silence *is* an expression of meaning, so that Freire's 'culture of silence' is a misrepresentation of 'Others'' choices. More generally, they argue that critical theorists have undertheorised power and tended to ignore or sideline differences within 'oppressed' groups and therefore oversimplify political positions. Arguing from Foucault (e.g. Foucault, 1979), power is not a thing that can be given or taken away, so 'empowerment' of students, by tutors, is a misplaced concept.

Elizabeth Ellsworth redefines the role of the 'critical pedagogue':

> *The terms in which I can and will assert and unsettle "difference" and unlearn my positions of privilege in future classroom practices are wholly dependent on the Others/others whose presence - with their concrete experiences of privileges and oppressions, and subjugated or oppressive knowledges - I am responding to and acting with in any giving classroom. My moving about between [positions] ... cannot be predicted, prescribed, or understood beforehand by any theoretical framework or methodological practice. It is in this sense that a practice grounded in the unknowable is profoundly contextual (historical) and interdependent (social). This reformulation of pedagogy and knowledge removes the critical pedagogue from two key discursive positions s/he has constructed for her/himself in the literature - namely, origin of what can be known and origin of what should be done. What*

> *remains for me is the challenge of constructing classroom practices that engage with the discursive and material spaces that such a removal opens up. (Ellsworth, 1992: 115)*

This is a fundamental challenge to critical pedagogy and suggests a new way of thinking about the classroom. There are for me three questions. Firstly, Ellsworth does not address the problem of a teacher's responsibility to respond to oppressive actions within the classroom - a key test, I think, of a tutor's position of institutional authority. The tutor is, usually, the 'origin of what should be done'; should the tutor abdicate that power even when there is, for example, overt racism or sexual harassment within the classroom? (In the course of this research I twice had to decide what to do when told about sexual harassment.)

Secondly, Ellsworth implies that the removal of the teacher from her positions as origin of knowledge and action can be done prior to, or separately from, classroom practices. Since (I would argue) authority relationships and classroom practices are mutually constitutive (Gee, 1996) - each reflecting or changing the other - we might equally start from classroom practices.

Thirdly, tutors are paid to be the origin of at least some forms of knowledge and action (and in Chapter 5 I discuss a group's approval of my 'dominant' position).

Nevertheless I have found Ellsworth's notion of unsettling discourse patterns very useful, and will use the term in this thesis. 'Unsettling' suggests 'rocking the boat' or 'making waves': it is not final, not complete, and has no fixed outcome or known destination, but it does refer us back to the taken-for-granted steadiness of the sea of dominant discourses we seek to challenge.

Mimi Orner argues that 'student voice', far from being the route to liberation,

> *[in the way in which] it has been conceptualized in work which claims to empower students, is an oppressive construct - one that I argue perpetuates relations of domination in the name of liberation. ... [D]emands for student voice in the Anglo-American feminist and critical traditions are highly suspect .... [C]alls for "authentic student voice" contain realist and essentialist epistemological positions regarding subjectivity which are neither acknowledged specifically nor developed theoretically. (Orner, 1992: 75)*

She concludes that we need a more detailed understanding of particular discourses:

> *What does seem possible ... is an attempt to recognize the power differentials present and to understand how they impinge upon what is sayable and doable in that specific context. (op. cit: 81)*

The poststructuralist critique of 'empowerment' and 'student voice' is summarised by Carmen Luke:

> *[W]e cannot claim one method, one approach, or one pedagogical strategy for student empowerment or for making students name their identity and location ... [W]e are not politically and ethically justified to assume positions of authority on 'negative identities': to assume that we have the power to empower or the "language of critique" with which to translate student speech and give it back to them in politically correct terms'. (Luke, 1992: 48)*

So far I have looked at the radical claims for adult literacy work and critiques of one-dimensional notions of voice and empowerment. Next I turn to the adult numeracy context.

5 Adult Numeracy Education (Adult Basic Mathematics)

I use the terms *adult numeracy* and *adult basic mathematics* according to their usage in the field (for example, a tutor may be contracted to teach either, depending on the college or the level of course); use of one term or another should not be taken to be significant. Adult numeracy education (in Britain) arose from AL work; in particular, many of the numeracy tutors had a background in literacy. We slipped into offering numeracy as well as literacy with very little consideration of the politics, epistemology or structures of mathematics, formal or informal. Adult education workers with more developed mathematical experience had to work hard to persuade many of their literacy colleagues, including me, to 'take maths seriously'. I use the plural 'we' here because I think I was quite typical; I do not however mean to suggest that *all* numeracy tutors were equally incurious about the politics or meanings of maths.

In contrast with AL work, which was founded in a more progressive tradition (we believed) than was possible for school English, adult numeracy work was founded in a domestic, vocational, 'coping' curriculum. We worked within what I would now characterise as a fictional view of 'real life' and 'functional skills', thus reflecting and supporting dominant discourses. This dominant strand is evident in ALBSU's numeracy standards, the basis for their maths qualification for adult numeracy students (Numberpower): handling cash, keeping records, making schedules and budgets, and finding measurements (ALBSU, 1993). As well as taking a strongly 'domestic' view of students (Freire identifies 'domestication' as the converse of 'conscientization'), such an approach serves very poorly anyone who might want to go on to more academic maths studies (for example, GCSE).

As I write, the government is introducing a standard Basic Skills for Adults curriculum, which by the very fact of listing 'five key adult roles' sets out to define and therefore constrain the construction of what we mean by 'adult'. These roles are wide:

- being a citizen

- taking part in economic activity, paid or unpaid
- managing a home and being part of a family
- leisure activities
- education and training (DfEE and Basic Skills Agency, 2000: Section 2)

but nevertheless exclusive. Work with drug users, prisoners, homeless people, lesbians and gays, and people with psychiatric illnesses, for example, can be squeezed into the list - but the onus is on the student and educator to do the squeezing, not on the government to be inclusive. The list of roles comes from a discourse which assumes a fair and open society in which students only need to improve their basic skills to enable them to contribute and benefit more fully. One example of the effect of this discourse on the detail of the curriculum is the omission of critical reading of mathematical information.

David Blunkett, Secretary of State for Education and Employment, made clear the new curriculum and increased funding for adult basic skills are led by the government's view of needs, rather than by a response to demand:

> *Opportunity for all is not only right, it is an economic necessity ... We have got to get people to accept there is a problem in the first place, and make it easier for them to admit they need help and come forward and access it. (Today, 27 June 2000, BBC Radio 4.)*

In Orner's (1992) terms, AN work has tended to position numeracy students as 'the Other', characterise their needs as related to preset roles (founded in a particular view of what 'working class' might mean), and limit their choices within mathematics.

The organisation of basic mathematics classes has typically been quite different from that of literacy classes. Most numeracy work has remained largely individual. Mathematics skills have been seen as both hierarchical and atomised, so that you must add, say, before subtracting, whereas in literacy the language experience approach is founded on the idea that you can write before you read, if you want to. This view of mathematics has led to provision in the form of individual programmes of study, progressing through a hierarchy of skills. There have been exceptions, for example Friends Centre Brighton, undated, and Tomlin, undated; however, critical or Freirean approaches have not been prominent. An ABE tutor/researcher summarises the perceived differences between maths and literacy:

> *For maths, a logical development, a series of progressive steps, is apparent. In literacy there is less of logical development, more of lateral relationships. (Andrews, 1992: 4)*

We can contrast that with Coben's invitation to use the language experience approach in numeracy:

> *This technique is ... applicable to numeracy practice in that students can record a situation involving maths which can then be 'solved' as a mathematical problem, by themselves and other students. (Coben, undated: 22)*

By and large, adult numeracy practitioners have agreed with Andrews rather than Coben.

Commenting on secondary schools' similar use of individual programmes, Woodrow argues that it was

> *a curriculum control issue and not one of freedom and "student-centredness". (Woodrow, 1997: 12)*

Focusing on individuals to the exclusion of group work may imply acceptance of the social and economic status quo, leaving individuals solely responsible for their failure:

> *The notion of democracy is inimical to isolation and individualism ... Justice and rights are social terms, they do not concern hermits! (Woodrow, 1997: 13)*

The importance of group work and space for students to work collectively became clear in the course of this research, and will be a theme running through the later sections.

Adult numeracy work has been astonishingly under-theorised in this country, partly because it has suffered from being tagged on to literacy. An influential article by Coben (1992), calling for more research, led to the formation of *Adults Learning Mathematics*, an international research forum with an annual conference and published proceedings, so that there is now a forum in which AN practitioners and researchers (with others working in further and higher education) share new theory and practice.

I will outline very briefly developments in the philosophy, sociology and history of maths and maths education which are relevant to the research reported here. This survey reflects my own take on the social construction of maths and on radical views of maths education, since that lies behind the research.

I argued above that literacies are socially constructed and inseparable from context, including power relations (this much is common to Freireans, 'critical' theorists, poststructuralists, critical discourse analysts and new literacy studies); similar views of maths are now gaining ground. Their common basis is a view of mathematics as socially constructed, though there are different and sometimes contradictory strands within that. Fields of research are developing in philosophy of maths (Ernest, 1991; Ernest, 1998; Skovsmose, 1994); sociology of maths and maths education (Davis & Hersh, 1981; Dowling, 1998b; Lerman, 1994; Lerman & Tsatsaroni, 1998; Restivo, 1998; Restivo, Bendegem, & Fischer, 1993); situated cognition (Lave, 1988); ethnomathematics (e.g. Powell & Frankenstein, 1997; Skovsmose & Vithal, 1997; Vithal, 1993; Volmink, 1990); and discourse theory and analysis within maths education (Baker, Clay, & Fox, 1996; Baynham, 1996; Benn, 1997a; Klein, 1998; Lee, 1995; Morgan, 1998; Sfard, Nesher, Streefland, Cobb, & Mason, 1998; Walkerdine, 1990b). Some of these fields are discussed in more detail with reference to AN work by Roseanne Benn (1997a); here I mention only those writers whose work has directly influenced or been used in the research reported here. I then consider Freirean perspectives on maths education.

5.1 Situated cognition

Theorists of situated cognition, building on the work of Jean Lave, argue that knowledge and mathematical strategies are socially formed and determined by culture and context (Benn, 1997a; Eisenhart, 1988; Evans, 2000b; Lave, 1988). Lave (1988) found shoppers using their own methods solving mathematical problems more effectively in the supermarket than when using 'standard' methods in a test. Similarly, Carraher, Carraher, & Schliemann (1985) tested children working as street market vendors and then in a formal pencil-and-paper test which used questions the child had handled successfully in the market place, expressed both as word problems and as mathematical operations with no context. The children got 98.2% of the questions in the market right, but only 73.7% of the word problems and 36.8% of the mathematical operations. Such research has had widespread influence, so for instance Knijnik (1998) and Powell & Frankenstein (1997), whose work I have used, both cite work by Lave and by Carraher et al. (A 'common sense' version of situated cognition theory is used by many AN tutors when we suggest students think of decimal figures as money; someone who cannot estimate 23.45 x 4 may well be able to do so when they think of it as four lots of £23.45.)

Roseanne Benn argues that the lesson from Lave's work is that since situated knowledge is not necessarily transferable, students need to

> *take time to understand the discourse of formal mathematics and to develop the ability to recognise and deploy the symbolic representations. .. The eventual payoff is a set of powerful methods which accomplish a lot of work in a little time and with little effort. (Benn, 1997a: 163)*

Benn seems here to assume that 'formal' maths is transferable where 'other' numeracies are not, though she does not argue that case. On the other hand, Europe Singh identifies the potential gap between tutors and students:

> *In so many adult numeracy classes it is so glaringly apparent. Teachers are confronted with students who have used mathematics all their working lives but once inside the classroom all that experience, all those self perfected rules of thumb become instantly redundant. The student insists on the primacy of the paper and pencil method and must perfect it. (Singh, 1993: 336)*

I have used some of the work reported in Carraher et al. (op. cit.) and Schliemann (1998) as a way of raising discussion with students about the notions of context-specific maths and transferability. Discussion of the Brazilian research, *because* street market children selling water melons are far distant from students' experiences in London, makes it possible for a group to stand back from an experience of failure in school contexts and reconsider whether 'failure' is a useful description of someone who has used mathematics appropriately in particular contexts. In Angelis' terms, contextual knowledge unpacks the non-neutrality of the dominant discourse in AE (Angelis, 1993: 309).

5.2 Ethnomathematics

The term ethnomathematics was coined by Ubiratan d'Ambrosio, in 1985:

> *Our subject lies on the borderline between the history of mathematics and cultural anthropology. We may conceptualize ethnoscience as the study of scientific and, by extension, technological phenomena in direct relation to their social, economic, and cultural backgrounds (D'Ambrosio, 1997: 13).*

D'Ambrosio argued that while work in ethnoscience and ethnoastronomy was developing, ethnomathematics was still unexplored. The distinction between pure and applied maths was developed in the era of Marx, Darwin and Kronecker:

> *For Third World countries this distinction is highly artificial and ideologically dangerous.... All the difficulties should not disguise the increasing necessity of pooling human resources for the more urgent and immediate goals of our countries. .. Ideology, implicit in dress, housing, titles ... takes a more subtle and damaging turn, with even longer and more disrupting effects, when built into the formation of the cadres and intellectual classes of former colonies, which constitute the majority of so-called Third World countries. We should not forget that colonialism grew together in a symbiotic relationship with modern science, in particular with mathematics and technology. (op. cit.: 22-3)*

The field of ethnomathematics has produced studies of culturally-defined maths (for example, Ascher & Ascher, 1997; Fasheh, 1991; Fasheh, 1997; Gerdes, 1997a; Gerdes, 1997b; Knijnik, 1998). There are however different, and conflicting, views on the implications of ethnomathematical studies for education. Some see ethnomathematics as a bridge to 'standard' mathematics: for example Taylor (1993) argues that Gerdes explicitly and Walkerdine (e.g. Walkerdine, 1990b) 'by sleight of hand' see standard maths as the end goal. Gelsa Knijnik (Knijnik, 1997a, 1997b, 1998) argues that choice of mathematical technique - local or 'standard' - is a political issue, so for example local or standard land measurement systems produce more or less land for the Brazilian *Movimento Sem-Terra* (movement of homeless people). Munir Fasheh seeks to use local knowledges productively; rather than only celebrating local traditions,

> *[mathematics] can be used to make one aware of the drawbacks in one's own culture and try to overcome them. (Fasheh, 1997: 284)*

He proposes international multicultural development of a syllabus based on the relationship between maths and cultural aspects:

> *Students who go through such a syllabus will, I believe, be able to understand themselves, their beliefs, and their culture better. They will also be able to understand other people and other cultures better. ... Most important, it will help, I hope, in fighting three of the biggest evils in our time: absolutism, intolerance, and ignorance. (op. cit.: 289)*

Fasheh's and Knijnik's approaches suggest that ethnomathematics can be used as a route to an overall view of maths as socially constructed and politically loaded.

An ethnomathematical perspective has been influential on the research discussed here. In particular, students read extracts from published research, which I had re-written to make them more accessible (with bigger print, shorter lines, and less jargon); these included Mozambican house design (Gerdes, 1997a), Brazilian land measurement (Knijnik, 1997b), British nurses' use of averages (Institute of Education, 1998) and Argentinean building workers' use of '6-8-10' (Pythagoras' theorem; Appendix 2 is a worksheet using Llorente, 1997). Ideas from ethnomathematical research may be included in teaching materials for several reasons: because they are useful ('good' or effective maths), because they lead to meta-knowledge of mathematics, or because they lead to analysis of students' own methods. Such extracts present evidence of the social construction and variation of maths, and contributed, I think, to discussions of individuals' different methods and maths histories. When Andy (from Jamaica) read of Argentinean methods to make square building corners, he commented that he used 3-4-5 to make staircases. When Sandra collected subtraction algorithms from students (Chapter 7) she had already had discussions about how methods vary with culture, history, language and particular context; her work could be seen as an ethnomathematics project, the social group in question being basic maths students in South London.

I do not seek in this thesis any resolution of ethno-/standard maths debates. Students come to a maths class assuming that what is on offer is 'maths' - that is, standard maths, mediated through government and institutional discourses. What I shall argue is that these debates can be shared productively with students.

5.3 History of mathematics

Alongside ethnomathematics is an interest in the history of maths, including the background and development of Eurocentric bias in the writing of that history (D'Ambrosio, 1997; Joseph, 1990; Joseph, 1991; Singh, 1993). Again, some of this has been used in teaching to support a case for the social construction of maths. I have for example used Joseph's account of the writing of maths history from a European perspective (Joseph, 1991; Joseph, 1997), Swetz' account of the linked developments of capitalism, the triangular trade and European use of the Hindu-Arabic number system (Swetz, 1987), and Lumpkin's description of a remnant of an ancient Egyptian architectural plan (Lumpkin, 1997). One of the aims of introducing such materials is to de-naturalise the maths course; if we can make clear that the course can only offer a selection of a highly limited set of strategies, usually from the 'ethnomathematics' of the academic world (or in some cases from the 'coping' numeracy curriculum), then the role of the teacher, or the institution, may be made more transparent.

5.4 Life histories in mathematics

Life histories in maths offer a link to adult literacy work and personal language histories (above). For example, Jeff Evans (1989), drawing on Frankenstein (1983) and Tobias (1978), suggests the use of diagnostic interviews, aiming to build a maths autobiography. Betty Johnston discusses the 'memory-work' of groups of women discussing their maths histories. She notes the silences:

> *None of the stories actually contained any mathematics. It seemed that not only had we learnt in context, we had learnt a context: it was the whole context that was remembered, though ... Why was the mathematics itself lost? (Johnston, 1995: 229)*

Coben reports that people may see the maths they can do as 'common sense'; 'maths' is what they cannot do (Coben, 1997). She links this to a discussion of Gramsci's concepts of good sense and common sense, arguing that we should avoid an over-simplistic identification of ethnomathematics with common sense and academic maths with good sense. Such an identification would be based on a view of common sense as unscientific and a lower form of knowledge, and would therefore imply that ethnomathematics is unscientific and privilege academic maths as the truth. But for Gramsci, good sense is the 'philosophy of praxis'; he would, we can presume, oppose its identification with elitist intellectual forms (Coben, 1998a).

Coben argues

> *In terms of the development of a radical, democratic politics of adults learning mathematics, it seems to make 'good sense' to start with adults' 'common sense'. (Coben, 1998a: 129)*

Students' oral and written discussion of their maths histories saturate the work reported here, from the comparatively formal written 'maths histories' in *Global Maths* (Chapter 10) to maths diaries (Chapter 4) and oral comments during and after classes. They range from records of standard algorithms - apparently 'pure maths' - to narratives with little obvious reference to maths; this material has in turn become research data read and discussed by other students as they consider their own histories.

5.5 Uses of discourse theory in maths education

'Discourse' has become a key word in maths education research as in literacy, although its meaning is often less clearly defined. Some discuss the production of mathematical texts and origin of mathematical problems, and ownership of the mathematical classroom, but the critiques of the concepts of 'empowerment' and 'voice' noted above seem to have had little impact on AN theory (so for example Roseanne Benn's book on AN is subtitled *Mathematics for Empowerment* (Benn, 1997a), and can be read as an empowerment handbook). Similarly work reported by Shirley Brice Heath, which included school students working as researchers in their community's mathematics (Heath, 1983), is rarely cited, although it has been influential in literacy theory.

Ethnomathematics and the history of maths are concerned with culturally (and economically) determined differences in mathematics - so we could write of *numeracies* in parallel with the NLS use of *literacies* (Johnston, 1996). Consideration of the gendered, class-determined and culturally limited discourse of standard maths suggests we could say it is not 'standard', but 'dominant'. Valerie Walkerdine's analysis of how people become 'subjected' in practices (Walkerdine, 1988) has been widely influential. Maths is central in her view of

> *the European aristocratic and bourgeois male [as] the model of a rationality founded upon a lifestyle in which the domination of the Other was to become to a certain extent justified by a reading of difference as inferiority (Walkerdine, 1990a: 52);*

the Other include both European working classes and colonised peoples.

Betty Johnston writes

> *[Mathematics becomes] an abstracted discourse that could refer to anything, and for most people refers to nothing [citing Walkerdine, 1992]. It is to experience mathematization as the ordered daily training in the normality of heteronomy [as opposed to autonomy]. (Johnston, 1995: 231)*

More recently some have started to apply ideas from discourse theory (Gee, 1996; Kress, 1989) and CDA (Fairclough, 1989), discussed above in the context of literacy work, to mathematics classrooms and texts (e.g. Lee, 1995; Morgan, 1998). There is a substantial movement in the USA towards 'writing-to-learn mathematics' (Elliott, 1996) (Appendix 1); Candia Morgan advocates the introduction of the techniques of critical language awareness into mathematics teacher training and the school maths curriculum, arguing that students need supportive strategies for 'learning to write' as well as 'writing to learn' maths (Morgan, 1998). While I have not used all the analytical tools from Fairclough and Gee, such theory has formed a background to my thinking and has influenced the research reported here and my reading of other researchers' work (discussed in Chapter 3).

5.6 Freire and 'literacy' in adult mathematics education; 'critical numeracy'

Freire's influence on adult mathematics education is much less well-established than in literacy education, but has been important to this research.

It seems that the word *literacy* has emblematic power within mathematics education, though it is not always related to Freirean perspectives. For example, a report on *financial literacy*, commissioned by NatWest, gives no definition of the term, but it seems to mean something akin to 'coping' (Schagen & Lines, 1996).

More often the use of *literacy* does come from an association with Freire; for example, Leone Burton's *literacy* refers to the political power of literacy, from a Freirean perspective (Burton, 1996), Betty Johnston draws parallels between the plural *literacies* of NLS and the critical *numeracies* she seeks to explore (Johnston, 1996), and Johnston, Marr & Tout argue from a Freirean and 'critical constructivist' framework:

> *Numeracy - like literacy - can be a double-edged sword: some programs use methods and materials that domesticate rather than liberate. Numeracy that emancipates should be based on methods and materials that increase autonomy and social understanding. In this model, knowledge, as well as being assumed to be 'viable' and constructed by the learner, is also situated and political, and learning and teaching involve questioning power relations both within and outside the classroom. (Johnston, Marr, & Tout, 1997: 168)*

A similar perspective is taken by Keiko Yasukawa, who argues that developing greater social awareness of maths abuse, and of 'political and mercenary manipulation of social statistics' (Yasukawa, 1995: 41), are important forms of empowerment, but may be ineffectual in breaking down the power of the maths 'abusers' (by 'abusers' I understand her to mean those who use mathematical tools to maintain differential power positions, and who use 'standard' mathematics as a test designed to exclude). She pays more than lip service to power relations in the classroom, a central concern throughout the research reported here.

We should note that in the usage of these (Australian) colleagues, 'numeracy' is defined as 'critical' numeracy; it incorporates the application of mathematics to develop a critical view of society. In this it is quite different from the usage of, for example, ALBSU and its successor, the BSA, who espouse the 'domesticating' (or at least domestic) curriculum. Ole Skovsmose (1994) traces the history of 'critical' education to the Frankfurt school of sociology and particularly Jurgen Habermas (1984). Skovsmose develops an argument for *mathemacy*, drawing on Giroux (1989) and Freire:

> *to understand [mathematics'] formatting power [is] an essential aspect of critical mathematics education. The object of critical study [is], therefore, located in the applications of mathematics ... Mathemacy [has] an importance similar to that of literacy, as a competence by means of which we become able to interpret and to understand features of our social reality. (Skovsmose, 1994: 207)*

A. K. M. Kibi uses the terms *critical mathematics literacy* and *empowerment* interchangeably, linking the concepts to South Africa's *People's Mathematics for People's Power*, in a discussion of the formation of a mathematics club for secondary students at an ANC school in Tanzania. Students formed commissions to investigate the farm, hospital, administration, garage and so on (in this the project sounds similar to some of Heath's work, mentioned above). These investigations were useful in reducing maths anxiety; however, they moved on to 'the specialised discourse of the discipline' (Kibi, 1993: 58), wanting not to pathologise students. Publication of students' findings through their own journal led to discussion in the whole community; 'the club was thus seen as a base for the surveillance of those members of the community who were occupying positions that made them decision makers' (ibid.).

Kibi discusses 'empowerment', arguing that for learners to be able

> *to act within the world in order to change it, they have to feel as custodians of the tools they will use. They have to discover that they can and have been thinking mathematically. This gives them confidence and a feeling of ownership of the discipline. (op.cit.: 59).*

Kibi cautions against Freire's 'Utopianism':

> *The right to be listened to presupposes equal availability and expression of different opinions. This cannot be inside the classroom. Teachers always feel that they are custodians of knowledge, more than the students can ever be. This imbalance cannot exist in the club, where the teacher's tasks are not as a resource of knowledge, but as a participant, maybe a senior one. (op.cit.: 65).*

Clubs - that is, spaces which are outside the direct control of teachers, though still subject to their influence - could also be spaces in which issues raised by students through their own mathematics journals could be discussed. Kibi suggests this because with large classes it is difficult to find time for individual discussion. Part of the research reported here concerns the importance of students' having student-only spaces, not to get enough time (in Britain we have far smaller groups), but to use as they will.

One of the most direct influences on the research was Marilyn Frankenstein's *Relearning Mathematics: A Different Third R - Radical Maths* (Frankenstein, 1989). When I read it I was enthused by her commitment to critical and radical education. Frankenstein's 'criticalmathematics' curriculum is based on a Freirean view of education (Frankenstein, 1994; Frankenstein, 1998; Frankenstein & Powell, 1994; Frankenstein, Powell, & Volmink,

1994) and uses students' mathematics histories, critical reading of statistics and economics figures and an ethnomathematical perspective. *Relearning Mathematics* is addressed to adult learners (rather than teachers) and I re-wrote the fractions chapter, with British examples, to use in my own teaching. Frankenstein suggests learners write their own review quizzes, and I incorporated that into my rewritten version. The result is that students' fraction quizzes in *Global Maths* directly quote from Frankenstein's own text (discussed in Chapter 8).

My doubts about Frankenstein's approach relate to what to me is an insufficiently sceptical perspective on the discourse of the classroom. 'Her' curriculum is identified as such; it is not (it seems) worked out in conjunction with the student group, and starts from her own perspectives on mathematics and society. The same may be true for 'my', or anyone else's, curriculum (though some may be severely constrained by institutional rules); however, problematising this 'power/knowledge' nexus is important.

Such doubts about the discourse of the classroom, and hence about the 'truths' found in research, have developed as I read more of the poststructuralist and feminist critiques discussed above. They are illustrated by my reaction to some work by Leonor Moreira and Susana Carreira. They discuss, from the evidence of a transcript, students' development of a 'democratic' stance arising from 'problem-posing' (Freirean) work on calculus problems founded in 'real world' statistics. One of the students, Cristina, 'reveals a progressive change of attitude towards the acquiring of a critical consciousness' (Moreira & Carreira, 1998: 275). This is a reasonable inference from the transcript, if we assume that what students say is a window into what they think, untrammelled by the discourse of the classroom. My doubt, acquired in the course of this research, is whether we can *know* from evidence given here that that is what happened. It could be argued that Cristina may just have got bored, or given up, or decided to agree. Perhaps we can never 'know'; insights from poststructuralist perspectives suggest we should at least be tentative.

Frankenstein, one of the most positive and determined of writers, herself expresses doubts when some of her students apparently reject such a 'critical consciousness':

> *They cling tenaciously to the "American Dream", to the belief that they too will "make it". Their arguments do not take into account all of the readings, all of the data, all of the discussions from the course about how our tax money is redistributed to the rich ... How to help students feel, at a deep enough level to challenge the American Dream, that things can be different, is the most unclear to me. (Frankenstein, 1994: 183-5)*

Here Frankenstein is caught in the dilemma identified by Orner in her challenge to 'critical' educators:

> *What does it mean for those of us who are teachers to struggle against oppression inside the classroom? How can we understand "resistance" by students to education which is designed to "empower" them? .... How do we teach as allies to oppressed groups of which we are not a part? (Orner, 1992: 75)*

Some of Frankenstein's students are 'resisting' education designed to 'empower' them. She has the Freirean dream - the Utopianism of which Kibi writes. Seeking to 'help students feel things can be different' is perhaps a euphemism for 'making' them feel it; the teacher knows the truth. On the other hand, Frankenstein's students will have no doubt of her political position, and perhaps that makes it more open to challenge than most.

5.7 The social construction of mathematics in this research

As literacies, numeracies, discourses and education workers are socially constructed, so am I. This extremely partial listing of developments in views of maths as socially constructed has focused on those authors or traditions whose work I have used in my own pedagogic practice, that is, who may have influenced both my and students' work in the research project.

6 Regulation and disorganisation in adult education

I have outlined very serious disagreements (sometimes disputes) among groupings from left, feminist, poststructuralist and critical perspectives around the notions of empowerment, voice and democratic pedagogy. In the 1970s and early '80s such debates were central to practitioners' choices. They now feel much more theoretical, in the weak sense of 'abstract' or 'divorced from practice'. Government policies have weakened LEAs' AE work and any associated liberal or radical tradition (Gardener, 1996; Mayo & Thompson, 1995; Sims & Blenkinsop, 1998), so that now the majority of AE is in the FE sector and even further from community control; ABE has to be justified on vocational grounds; progress of students, or value of schemes, is defined in terms of accreditation of students' work (Mayo, 1995; Ross, 1995; Shaw & Crowther, 1995); and education is a market (Maguire, Macrae, & Ball, 1996). Individual solutions are sought for problems formerly identified as social (Hamilton, 1998; Street, 1997a; Wolfe, 1998), although there are some attempts to incorporate group collaborative work into the accreditation framework (Sanders, 1997). The new Adult Basic Skills curriculum will be supported with an increase in funding, but it's at least likely that it will be difficult to work within it as a radical adult educator. As Sue Gardener puts it,

> *We occupy and work in a space which appears to be highly regulated, centralized and organized but which is at a deep level highly disorganized. (Gardener, 1996: 6)*

Many tutors in AE teach longer hours, with larger classes, and have lost political confidence:

> *Exhausted, bemused, defensive, no longer sure of our ground, many [tutors] work in an inhospitable ideological terrain and grapple interminably with practical, intellectual and ethical questions. Is the disintegration and apparent disappearance of a praxis which sought to reflect the relationship between education, democracy and class consciousness and which was occasionally brilliant, often muddled and usually flawed, an outcome of a changing constituency, a new labour and social paradigm? Are we, have we been, hopelessly out of step with people's feelings, intellectually bankrupted and displaced in a world which has passed us by? ... In 'taking' education to the people, are we caught up as active agents of crisis management living at best symbiotically, at worst parasitically off ravaged lives? (Ross, 1995: 232)*

Much of the research discussed in this thesis was undertaken with and/or by students who, like me, were grappling with an 'inhospitable' terrain. Most were working in comparatively formal settings, in groups twice the size of those of the 1970s, towards formal accreditation of their work, and our maths education and research choices were sometimes defined by the need to 'get a tick' for a 'skill' or 'learning outcome'. The same students were engaged in

> *the unwaged work of sustaining the social fabric, [with the] particular energy and desperation [of] those who can't escape the worst stresses of the present. (Gardener, 1996: 6)*

The research which follows tells some of the stories of what happened with a tutor with this history and these contradictions endeavouring to work collaboratively with students in a participative research project.

The following research questions are drawn from this chapter and addressed in the thesis:

1. *What does 'radical' mean in adult numeracy work, for me, in Britain, now?*
2. *Does this research fit a Gramscian or Freirean model, and if so, how?*
3. *What and how can tutors 'negotiate' in a government-funded numeracy course? How does negotiating the curriculum have a bearing on voice and empowerment?*
4. *What is the action in this research? In what sense is this research participatory?*
5. *What do pedagogic practices from literacy bring to the numeracy classroom?*
6. *Is there a necessary connection between tutors' and students' epistemologies of maths and classroom practices? How does students' own maths experience fit into a negotiated curriculum and into dominant, 'standard' maths?*

Chapter 3: Methodology

In Chapter 2 I outlined the contexts for this research, including 'critical' and 'post-critical' (Lather, 1986) perspectives. Renuka Vithal suggests that research in critical maths education 'can be largely identified with ethnography and action research' (Vithal, 2000b: 98). She comments,

> *What has still not been adequately developed are a set of reflections at a meta-level in research that begin to put forward a coherent and comprehensive theoretical framework for doing research in this mathematics educational landscape. (Vithal, 2000b: 98)*

Vithal lists seven 'key issues' in the development of such a framework: choice; negotiation; reciprocity; reflexivity; subjectivity-objectivity; context, change and instability; and emancipation, empowerment and hope. These have overlaps with the themes I developed in this thesis. Vithal suggests that critical research takes issues regarded as 'ethical' in other research paradigms and makes them 'methodological' (Vithal, 2000a). Such considerations illustrate the complexities and ambiguities in research in which methodology and outcomes are reflexively related and may be difficult to distinguish from each other, as is the case in the research reported here. In Chapter 11 I raise the question of whether my research should be described as furthering 'ethical', rather than 'radical', adult maths education.

This chapter is in four sections:

- relevant methodological issues from ethnography
- the nature of this study
- data collection and analysis
- academic literacy, rewriting history and staying at home.

1 Relevant methodological issues from ethnography

I have taken a broadly ethnographic approach, defined by Hammersley (1994) as social research which has most of the following set of features: empirical data; real world contexts; observations and informal conversation as the main sources; it is unstructured and small scale; and the analysis involves interpretations of meanings and functions of human actions. Eisenhart's equivalent list of features includes participant observation, ethnographic interviewing, a search for artefacts and a content search of relevant written or graphic materials, and researcher introspection (Eisenhart, 1988: 105-6). This research has included all these features.

Green & Bloome distinguish between *doing ethnography*, *adopting an ethnographic perspective* and *using ethnographic tools*. The last

> *refers to the use of methods and techniques usually associated with fieldwork. These methods may or may not be guided by cultural theories or questions about the social life of group members. (Green & Bloome, 1997: 183)*

While I have used ethnographic tools, I have done so within the frameworks described in Chapter 2 - broadly, theories of adult literacy and numeracy work as 'empowerment', theories of critical education and discourse theory (use of teacher knowledge and theory will be discussed below).

Green & Bloome also distinguish between ethnographic studies *of* and *in* education. The latter are grounded in knowledge derived from the field of education, and include ethnography among students in classrooms, where research agendas may include the exploration of students' own communities, including making the community's 'heritage, knowledge, and way of life, visible and respected' (Green & Bloome, 1997: 193); the promotion of the learning of academic, disciplinary based knowledge; and social and political change in the students' communities.

These elements are relevant to this study. The magazine *Global Maths* (Chapter 10; Appendix 10) is an example of making students' knowledge and heritage visible. This research has not directly addressed questions relating to 'communities' in the implied sense of communities outside the classroom. However, students have themselves brought in 'outside' issues (ranging from the uses of mathematics at work and in the home, to family histories); these will be discussed in the thesis. The term 'community' in maths education discourses today is often associated with Jean Lave's theory of communities of practice and situated cognition (Benn, 1997a; Boaler, 2000; Evans, 2000b; Lave, 1988). I have not focused on theories of learning, and my use of 'community' is much looser - a group of people with some shared experiences and aims and a sense of joint endeavour. A central issue has been discursive change in the classroom and in effect the promotion of classrooms as communities (for example, one theme will be the students' emphasis on the benefits of discussion and group work).

Eisenhart notes that the ethnographic researcher

> *tries to learn to be a member of the group by becoming part of it and, on the other hand, tries to look on the scene as an outsider in order to gain a perspective not ordinarily held by someone who is a participant only. (Eisenhart, 1988: 105)*

As the tutor I could neither be a member of 'the group' (if that means students) nor an outsider. Todorov argues that anthropologists have historically seen *distance* from the society being studied as centrally important, but that *detachment* is a more useful concept:

'The climax of [an] anthropological education is ... not distancing (in relation to others) but detachment (in relation to oneself)' (Todorov, 1988: 4). I have not achieved, and was not aiming for, 'detachment' in relation to myself; on the other hand, I do now see myself differently, both as an academic researcher (section 4.1) and as a maths tutor.

The impact of the tutor-student relationship on both classroom and research discourses, and changes in that relationship resulting from research and related teaching practices, are discussed throughout the thesis. In particular, some of the students took leading roles in the research (for example, organising classroom observation, a students' meeting and a magazine), and did so at least in part because I invited them to. Freebody (1998b) argues that interviews are not 'data collection' but 'data production'; the same could be said for all the data presented here. Hammersley writes that the ethnographic researcher 'seeks to minimise her or his effects on the behaviour of the people being studied' (Hammersley, 1994: 5). In contrast, this thesis can be read as a case study of my own work (section 2.4); I was one of the people studied, and sought to maximise the effects of the research on my behaviour.

So far I have said the thesis is not ethnography, though the research used ethnographic tools. In the next section I consider some other ways of describing the thesis.

2 The nature of this study

Here I hold this research up against other relevant paradigms for the description of education research and writing. They overlap, but for reasons of clarity I will consider them separately:

- participant action research
- teacher research
- a narrative containing other narratives - telling the story/ies of what happened in the research project
- case study/ies (of my own work and of students' work).

I will then consider issues of generalisability and generativity.

2.1 Participant action research

I would argue that the work reported here falls broadly within participant action research, though with some important reservations. We saw (Chapter 2) that Merrifield's definition of PAR included research being owned and controlled not by researchers but by people who need the research (Merrifeld, 1997). There is a tension between my ownership of the research as a PhD student, and hence its academic framing, and students' ability to read it, much less 'own' it, in its entirety (this will be discussed further below). Much of the research focuses on issues of discourse and power in the classroom; from this perspective the notion of the research being controlled by the students should be seen as a framing aim or ambition rather than an achievement. The research casts some doubt on whether it is ever possible to say texts are owned by one or another party in any straightforward way.

2.2 Teacher research

Marilyn Cochran-Smith and Susan Lytle trace teacher research back to earlier fields of action research: the teacher is a participant and similar claims are made for the 'empowerment' of students and generation of research questions from experience. They base their argument for teacher research on an epistemological claim:

> *The base for teaching is complex, encompassing knowledge of content, pedagogy, curriculum, learners and their characteristics, educational contexts, purposes and values, and philosophical and historical grounds ...The notion of theory as a combination of perspectives will be particularly compatible with and productive for the emerging genre of teacher research ... If we regard teachers' theories as sets of interrelated conceptual frameworks grounded in practice, teacher researchers are both users and generators of theory. (Cochran-Smith & Lytle, 1993: 17)*

The attraction of this perspective for any teacher is that it values our knowledge; the 'philosophical and historical grounds' of my own work are outlined in Chapter 2, and the research is grounded in questions emerging from 'discrepancies between what is intended and what occurs' (op. cit.:14).

Cochran-Smith & Lytle claim that

> *through inquiry, teachers would play a role in reinventing the conventions of interpretive social science, just as feminist researchers and critical ethnographers have done by making problematic the relationships of researcher and researched ... and subject and object. (op.cit.: 43)*

I would argue that they have to make such grand claims because their text is intended to challenge more traditional research on its home territory. Their examples of teacher research include teachers' journals, but such comparatively informal, reflective writing is only validated by its inclusion in an academic text. I argue in section 4 that the kinds of framing needed to achieve academic recognition render research less accessible to students.

This issue becomes clearer if we replace Cochran-Smith & Lytle's *teachers* with *students* in these sample quotations:

> *What is missing [from current research] ... are the voices of teachers themselves, the questions that teachers ask, and the interpretive frames that teachers use to understand and to improve their own classroom practices. (op. cit.: 7)*
>
> *Teacher researchers are both users and generators of theory. (op. cit.: 17)*
>
> *Teacher research emanates from teachers' own questions and frameworks [and] reveals what teachers regard as the seminal issues about learning and the cultures of teaching. (op. cit.: 20)*

I would argue that if we accept these statements about teachers, we could consider them for students too. Cochran-Smith & Lytle claim that

> *because teacher researchers often inquire with their students, students themselves are also empowered as knowers. (op. cit.: 43)*

However, this risks contradiction from students' exclusion from the category of researchers. Brian Street summarises Cochran-Smith & Lytle as adopting

> *a form of empowering through interacting that may be more valid than claiming to empower by 'giving a voice' or 'representing' one's subjects, where the researcher is still in control. In the former case, it is up to the subjects whether the alternative interpretations and the methodologies for analysis and perception offered by the researcher are actually used. (Street, 1993: 15)*

This surely is only the case if subjects have some control over 'writing up' and dissemination. If subjects have little access to this form of the research, they still may be effectively excluded.

My research is clearly 'teacher research' in many ways, and Cochran-Smith & Lytle's justification of my reference to my own work history and an oral research tradition (Chapter 2) is helpful. While recognising that their stance is a deliberate challenge to the dominance of research 'on' or 'into' teachers' work, I would argue they underestimate the power of academic discourse and the difficulty for teachers (and students) attempting to insert themselves into it.

2.3 A narrative containing other narratives - telling the story/ies of what happened in the research project

Overall the structure of the thesis can be read as a narrative with other narratives embedded in it; Chapters 4-10 tell stories from the research. Within that overall shaping, some sections are not narrative. The longest clearly non-narrative sections are this, on methodology, and Chapter 11; Chapter 2 presents two intertwined stories, of literacy and numeracy developments in the UK, but its academic framing makes the 'storiness' harder to find. I shall argue that the form of 'writing up' of the research is inseparable from the 'content' and methodology, using Dell Hymes' discussion of 'narrative inequality' as my starting point.

Hymes argues that we tend to depreciate narrative, particularly personal narrative, as a form of knowledge, in contrast with other forms of discourse considered academic, technical, and so on. This is

> *part of a general predisposition in our culture to dichotomize forms and functions of language use, and to treat one side of the dichotomy as superior ... Different dichotomies tend to be conflated, so that standard : non-standard, written : spoken, abstract : concrete, context-independent : context-free [sic], technical/formal : narrative tend to be equated'. (Hymes, 1996: 112)*

Hymes' 'written : spoken' dichotomy reflects my concerns about the lack of credit accorded to oral discussions of theory and practice in ABE.

Hymes' case is that

> *if one considers that narrative may be a mode of thought, and indeed, that narrative may be an inescapable mode of thought, then its differential distribution in a society may be a clue to the distribution of other things as well - rights and privileges having to do with power and money, to be sure, but also rights and privileges having to do with fundamental functions of language itself, its cognitive and expressive uses in narrative form. (op. cit.: 113 - 4)*

A central purpose of this thesis is to examine the discourse of basic maths classrooms, so Hymes' 'rights and privileges' are crucial. There is a tension between the discourses and academic literacies of examiners and those of 'the field' - both practitioners and students. The students whose work (oral and written) is used in this research should as a minimum have some control over how that work is exploited. Three immediate issues relating to the use of narrative forms arise for my own writing.

The first is how I represent students' writing or speech: to bury their words under my own abstracted summary denies Hymes' 'rights and privileges having to do with fundamental functions of language itself', or in terms of earlier debates in literacy, denies their 'voice' (Chapter 2). Hence I sometimes quote relatively continuous sections of writing or speech (section 3.5).

The second issue is the overall shaping of the thesis and the decision to present data and discussion in episodes (Chapters 4-10). One reason for presenting data in episodes is that this may help preserve context for the reader. The discourse within which a text was produced affects its interpretation. While the episodes are not 'narratives' in Hymes' terms, they do include narrative elements, filtered through my own focusing. Hymes writes that

> *performance and text [are grounded] in a narrative view of life - that is to say, a view of life as a source of narrative. Incidents, even apparently slight incidents, have pervasively the potentiality of an interest that is worth retelling. The quality of this is different from gossip ... Not that the difference is in the topics. The difference is in the silences. There is a certain focusing, a certain weighting. A certain potentiality, of shared narrative form, on the one hand, of consequentiality, on the other. (op. cit.: 118)*

Hymes argues that *everyone* makes an appeal to narrative forms of understanding. Even if overt narratives were excluded, academic and other 'non-narrative' forms of writing would be

> *interpreted silently in terms of representative cases, and representative cases inevitably embody representative stories ... One's choice is not to exclude [anecdotes], but to choose ones that are appropriate and adequate. (op. cit.: 114)*

The narrative use of language 'is considered legitimate ... when it is used *among co-members of a group'* (original emphasis; op. cit.: 115). I have already attempted to give credit to the many conversations with tutors and students that have shaped both my theory and my practice (Chapter 2). By citing Hymes here, I am seeking to explain the use of elements of narrative form to co-members of a different group (academics).

The third issue is the need to be able, as far as possible, to explain to students how their work is being used in my work. Where possible I have checked not only data (transcripts, use of photocopied material, etc) with students, but also shown them first drafts of my own comments. This has often involved reading my own work aloud and skimming or summarising sections which are too academic to be accessible. This oral editing already limits students' chances of challenging what I write. If 'their' material is left largely 'in one place' students may at least be able to approve or challenge my conclusions from that episode.

This leads to a fourth issue: my own use of narratives during the research. A central problem for the researcher is to identify themes which appear to transcend individual episodes or anecdotes - that is, to be relevant to a wider audience. Students themselves generalise their experience: for instance, students' stories about tutors at the students' conference led to Lorraine's generalisation, *tutors are sort of loudly spoken* (Chapter 9). Students' choices of anecdotes are, as Hymes says, themselves selected for their 'consequentiality'. Students at a RaPAL conference told the story of their own conference, and used it to expound the value of seeing students as researchers (Gray et al., 1999). Because students move on, my own generalising from all the episodes has been subject to less rigorous checking than I would have liked. One way that I have generated discussion about 'other' episodes than students' own is through editing and sharing (in writing and orally) anecdotes from other groups. For example, Paulette's and Cindy's interview (Chapter 4) has been told as a story to every group I have worked with; this involves my own judgement about 'consequentiality'.

No doubt other researchers would choose different stories for their own 'focus' and 'weight' (Hymes' terms). My choices finally come from my experience of what narratives have formed my own theory and practice as a literacy and numeracy tutor (which stories have 'worked' for me); from that I make a judgement that the narratives re-presented here will be interesting to 'co-members of the group'. The tension remains over which 'group' - academics or literacy/numeracy practitioners, including students.

2.4 Case study/ies (of my own work and of students' work)

I noted above Hymes' emphasis on 'potentiality' and 'consequentiality' as criteria for anecdotes. Those criteria form a link to case studies - how do we choose them, and what lessons do we think they can carry?

Cochran-Smith & Lytle (1993: 59) say

> *Almost by definition, teacher research is case study.*

Hammersley defines a case study as one case selection strategy, the others being experiment and survey. In experiments, the researcher

> *creates the cases to be studied through the manipulation of the research situation, thereby controlling theoretical and at least some relevant extraneous variables. (Hammersley, 1992: 185)*

Both teacher research (as discussed by Cochran-Smith & Lytle) and my own work to some extent fit this description of experiments: as a teacher I have 'manipulated' my own work in response to the developing research. On the other hand the work didn't feel like an 'experiment'. The notion of controlling variables to improve the chances of checking causal relationships doesn't fit with the work described here; most of the groups of students with whom I worked were 'naturally occurring' adult education classes. Hammersley argues it is not the case that we either create cases or study existing ones; there are midpoints on the scale (for example, field experiments).

One of Hammersley's (1992) suggestions for improving the generalisability of case studies is to select cases that cover some of the main dimensions of suspected heterogeneity in the population in which we are interested.

I would argue that the groups with whom I have been working are typical in terms of their institutional and organisational set-up: class sizes, length of course, advice and enrolment procedures, funding and accreditation arrangements, tutor support and teaching resources were similar to most FE and adult education. Colleague tutors would recognise the constraints: for example, only the community centre had a computer available for students or staff to use, and both the FE and LEA centres underwent restructuring, cuts to staffing and an increase in class sizes during the period of the research. Since a central concern of this project is the discourse of adult basic maths education, it is important that the institutional power structures are broadly similar to those of most adult basic education. My work experience is similar to that of many colleagues (at least those of a similar age), and the broad aims with which I started, of empowerment and strengthening students' voice, are or were (Chapter 2) those of the mainstream discourse of adult basic education. Hammersley (1992) argues that typicality can be checked against studies by others in a similar population in the same period. That is not possible (as far as I know there are none), but I would claim from my own experience that the groups are, if not 'typical', recognisable to other tutors and organisers.

However, in other respects I would not want to claim the research shows a 'typical' case. My own position as researcher made me an atypical tutor in many respects. Within the project, there was significant disagreement between students in several areas (for example, whether overtly political worksheets were interesting or not). Mitchell argues that

> *A good case study ... enables the analyst to establish theoretically valid connections between events and phenomena which previously were ineluctable. From this point of view, the search for a "typical" case ... is likely to be less fruitful than the search for a "telling" case in which the particular circumstances surrounding a case, serve to make previously obscure theoretical relationships suddenly apparent. (Mitchell, 1984: 239)*

Thus case studies may not be 'illustrations', but ways to develop theory, because there are contradictions or gaps between the cases studied and the theoretical formulation of the 'regularities' underlying the case (op.cit.: 240). In this research, the 'regularities' exposed as contradictory include, for example, the notion that writing in maths necessarily helps students express and develop their ideas, or that ABE students always want to work only on 'practical' maths.

There has been very little research into the discourse and practices of adult basic maths education. What is presented here can be seen both as a 'telling case' of an attempt to undertake that research, and a series of telling case studies of adult basic maths education discourse and practices.

2.5 Generalisability and generativity

So far I have said that I used ethnographic tools and that the research has overlapping elements of participant action research, teacher research, narrative writing and case studies. If the research is to be useful to anyone beyond me and the students involved, it must offer interpretations which apply more widely than our immediate context. Hammersley comments,

> *One of the key problems in ethnographic analysis is finding an overall theme, model or argument which organizes the data in a coherent and forceful way. Only then does the line between the relevant and irrelevant become clear. How*

> *ethnographers acquire such models is shrouded in mystery. Often, they simply talk of an overarching model 'emerging" (Hammersley, 1984: 60).*

Early on I asked in my research journal, 'Isn't a possible finding that there *isn't* such an overall theme?' The thesis will explore, among others, two 'emerging' themes which have shaped the methodology: students' roles as researchers, and students' resistance to generalisations about themselves.

Cochran-Smith & Lytle defend teacher research against the charge that its lack of generalisability reduces its value; they claim 'understanding one classroom helps us to understand better all classrooms' (op. cit.: 13). Yet my sense of a mismatch between theory and practice which led to my own research questions arose as much from teacher research as from 'research on teaching' (their alternative paradigm); I would argue teacher research does support understanding other classrooms but perhaps because it is more amenable to challenge from teachers who can test it against their own experience.

The themes 'emerging' in this research fit the notion of *generativity.*

Paola Valero and Renuka Vithal propose 'generativity' as a criterion of the value of research (and Julia Ellis (1998) makes a similar point about work with students as researchers):

> *Generativity can be taken as the extent to which a study originates new research objects for study and alternative research methodologies, as well as produces new outcomes. (Valero & Vithal, 1998: 5)*

Valero and Vithal problematise the assumption of stability underlying research in the developed world. Researchers need to be

> *open to the possibility of changes in the research process, but also to be more radically responsive and flexible in actually modifying their research objects, as disruptions in the context and, therefore, in the methodology appear. (op.cit.: 5)*

They are writing of situations disrupted by political actions; however, their argument is applicable to some of the students involved in this study, who live necessarily disrupted lives (examples from active participants during the research period: one was burnt out of her house; two have severe epilepsy; two were sexually harassed; one had a long period in hospital; two were cut off from disability benefit in a government campaign to reduce costs). Instability in group attendance is common in ABE (a typical response in terms of course organisation is a workshop approach in which students work individually, discussed in Chapter 2).

The 'disruptions in the context' of this research have included not only shifts in the student groups but also direct responses to the processes of the research - an inevitable, and positive, result if students are involved as researchers. I would claim that this research offers 'generative' rather than 'general' findings.

3 Data collection and analysis

3.1 Introduction

The methodology has varied in response both to developing experience (so for example Cindy and Paulette (Chapter 4) changed my view of the function of interviews) and the particular people with whom I worked (for example, some wrote directly on paper while others dictated to me or another student). Methodology is therefore inseparable from the data and findings. Indeed, one conclusion from the research is that the kinds of data may determine the researcher's (or teacher's) responses (for example, data to be analysed in the thesis includes evidence that it is not safe to read written texts as transparent windows into the writers' thinking). Further, because of my own position as a participant my reading of the data is highly reflexive.

Cameron et al. (1992) define three types of relations between researcher and researched: ethical (research *on* subjects), advocacy (research *on* and *for* subjects) and empowerment (research *on, for and with* subjects). The last leads to the following programmatic statements:

> a) persons are not objects and should not be treated as objects
>
> b) subjects have their own agendas and research should try to address them
>
> c) if knowledge is worth having, it is worth sharing. (Cameron, Frazer, Harvey, Rampton, & Richardson, 1992: 23-4)

The authors argue that these approaches may remove the category of 'expert knowledge', since it will be revealed as derived from subjects' own knowledge. They identify a contemporary convention of reproducing subjects' own words on the page unmediated by authorial comment, in order to give the subject a voice of her own and validate her opinions (op. cit.: 25). In the present research these issues have been problematised. The category of 'expert knowledge' has been challenged but not removed, given the researcher's position also as tutor. Reproduction of the subjects' 'own words' on the page is itself problematic: for example, some students wrote through a scribe, who may have considerable control (Chapter 2); tape transcripts are always subject to the transcriber's choices (section 3.4.6); the students' 'own words' were under constraints from the discourses within which they were operating (Gee, 1996; Gee, 1999); above all, I have had editorial control over in/exclusion of episodes and texts in this thesis. In some cases I edited subjects' words in order to make research and teaching materials to use with other groups. While I have aimed for Cameron et al's 'empowerment' relation with the students, the research itself has called into question the empowerer/empowering relation.

For these reasons each section of data analysis will include some reference to relevant methodology. Here I shall outline those features which are general to the whole project.

3.2 The participants and research contract

Data collection started in September 1996 and continued until June 1999, though since then I have remained in touch with several participants and had informal discussions with them. In that period I worked with five adult numeracy classes: two in an LEA community education service, one in a Further Education college, one in a community centre, and one in a psychiatric forensic unit. For ethical reasons I did not invite the last group to participate, though it is inevitable that insights gained through working with them have informed my work.

The other classes are typical of late 1990s adult mathematics education. With the exception of the community centre, the courses were funded through the Further Education Funding Council. The institutions therefore wanted students where possible to gain qualifications; where the particular qualification is relevant to the research, it will be identified. Courses are organised on the assumption that students attend for two hours a week, for a notional year from September to July; in fact as with much ABE, attendance was erratic, and some students started the course late or continued into the following year. All the courses were defined as 'basic maths'; however, since there is comparatively little provision of adult maths education within ABE, 'basic' is a broad category. For example, in one centre English was organised at four levels, whereas maths was at two levels: basic and GCSE. Students' skills in one group ranged from difficulty in addition to pre-GCSE work. (The notion of 'negotiating the curriculum' is one of the questions raised in Chapter 2.)

At the community centre I worked as a volunteer; the course was largely unfunded, though it benefited from active encouragement and support from the centre workers, administrative support such as use of the photocopier, and free use of a building for the students' research conference (Chapter 9). Some of the most active researcher-students came from the community centre; this will be discussed in Chapter 9.

Some students dropped out from courses after a few weeks; the majority stayed for at least six months. I gave all the students a leaflet (Appendix 3), which I read aloud and discussed; it is consistent with the recommendations of the British Association for Applied Linguistics (1994). All the students agreed to take part in the research, although their active participation varied considerably. As with everything in this project, their agreement has to be 'read' in the context of a classroom discussion in which I was their tutor. I adopted an informal policy of seeking active participation only from people who inquired further into the progress of the research.

The following table shows the total number of participants. 'Total students' represents all those who attended courses and who agreed to the research; the 'active participants' are a sub-set of the total number. 'Active' is defined as willingness to be cited in the research; this ranged from willing to be identified in my field notes to taking part in organising the research.

Year	Centre	Time of course	Usually attending class	Active participants
1996/7	Wandsworth Adult College (FE)	Evening	10	3
"	Lambeth Community Education (LEA)	Morning	11	10
"	" " "	Morning	8	8
"	Bede Education Centre (non-statutory)	Afternoon	8	4 + 3*
1997/8	WAC	Evening	10	8 (2 returning from 96/7)
"	LCE	Morning		8 (1 returning from 96/7)
"	LCE	Morning	3	3
"	Bede	Afternoon	4	4
1998/8	WAC	Evening	12	4 (2 returning from 97/8)
	Bede	Afternoon	5	3 (1 returning from 97/8)
Total (counting individual people rather than years of attendance)			66	49

* three people joined the group organising the *Meeting for Maths Students for Beginners*: one friend of a student who stayed in the class, one student from a different maths course, and a literacy student.

I must emphasise that of the 49 active participants, some were only 'active' insofar as they gave permission for specific data to be used. About twenty students saw themselves as actively involved in the research (for example, taking part in interviews, or organising class observations). In addition, about 25 people not included in the table above came to the students' conference, and others contributed to *Global Maths*. Altogether about 75 gave permission for specific data to be used, and about 50 were involved in interviews, group projects, the students' conference and *Global Maths*. Within the fifty, involvement varied from taking part in a taped class to helping organise the conference. Despite the apparently small numbers, this compares well with a US national study, where 171 students each attended one focus group meeting (Curry, Schmitt, & Waldron, 1996). Further detail of participation will be given in Chapters 4 - 10.

3.3 Literacy

The central focus of this research is on mathematics, not literacy. However, the relationship between the two in organisational terms is important, and literacy issues are central to the analysis of data from mathematics students. Throughout the research period I also taught literacy groups (two classes a week in 1996/7, and one in 1997/8/9). Although most of the mathematics students also attend literacy courses, only one in 1996/7/8 and one in 1998/9 were taught by me for both subjects. All the mathematics students knew I taught literacy and many raised issues of spelling and/or reading difficulties with me.

In most cases where literacy issues are relevant they will be discussed with the data analysis. Here I should make a general point about the conduct of the mathematics classes. Whenever the whole group read a text, either I or someone from the group read it aloud, and in some cases I also discussed it to ensure its meaning was as clear as possible. Any student could ask me to take dictation from them, and most, including those without apparent difficulties in spelling, did so at some stage. Where relevant the implications of these practices for the analysis of data will be discussed in the body of the thesis.

3.4 Ethical issues

As the contract made clear, a general agreement to take part in the research did not give me permission to use specific data. Wherever a student is cited, or her/his work given as an example, I have asked the individual for permission and checked how s/he wanted to be named. Because of this, some individuals are named (with real names or their own choice of pseudonym) in some contexts, but identified only as 'a student' in others, and some students have the same name; the thesis cannot be read as case studies of individual students. Where relevant I have checked descriptions of students (e.g. 'has disabilities'). Permission to use data was occasionally refused, and I have respected that.

All the courses included at one time or another students with mental health problems. This led to particularly difficult ethical choices. It was sometimes unclear to me whether the student fully understood what I was requesting. I did not want to rule out all data from students with mental health problems since that might both discriminate against them and misrepresent the courses; I also did not want to exploit any ambiguity in their expression of their wishes to my own benefit. I hope I made the right judgements.

3.5 Data collection

3.5.1 Notes

I kept notes of class meetings, planning meetings with students and informal discussions with students which seemed potentially significant. It is inevitable that some data was lost, since as class tutor I had to write most notes after the class, rather than during it. In Roger Sanjek's terms, I wrote *scratch notes* during or immediately after the class (before leaving the room), and *fieldnotes* based on the scratch notes either the same day or the following morning (Sanjek, 1990). The fieldnotes were organised as notes about the whole group, with additional notes filed separately about individuals. Both were typically 100 - 500 words long.

Developing reading (of theory and of other empirical research) also contributed to the data. My own fieldnotes include references to my reading; my reading notes include references to the data; and both show analytical ideas and research questions being formulated (Sanjek's (op. cit.) *headnotes*).

3.5.2 Written materials

Where students gave permission, I kept copies of their class diaries or records of class work, and in some cases other writing and mathematical work. In addition some of the students' writing (for example, written mathematical problems, and maths histories) became a key focus of the developing research and were discussed in more detail with students. Some students wrote notes giving their ideas for data analysis or the direction of the research.

3.5.3 Interviews

I taped interviews with four students (two of them together) about pieces of their writing. In addition two students interviewed each other using my questions. Some discussions were not taped because I or the students judged the taping to be unhelpful. Finnegan (1992: 83) suggests recording may be 'threatening or glamorising (or both)'. While I doubt if anyone found it glamorising, Cindy and Paulette did use the tape to produce something akin to a radio script, whereas Sandra (interviewing other students) decided against tape recording because 'people would pull back' .

3.5.4 Whole group discussions

I taped three whole-group discussions about the research and students' mathematical work. In addition, I taped a group discussion which turned into an exploration of fractions, and two discussions amongst the organisers of the *Meeting for Maths Students for Beginners.*

3.5.5 Classes

Two classes were taped: part of work on an investigation (Chapter 6), and on handling data (Chapter 5).

3.5.6 Transcription

All but two of the tapes were fully transcribed. In one case, when the group heard the tape they were dissatisfied with what they had said. The other was the tape of the handling data class, which had very poor sound quality. With the group's permission I transcribed only about 15 minutes of the tape (Chapter 5).

Everyone who was taped wanted to listen to the tape as soon as we stopped recording, and all gave permission for transcription with the exception of the one group mentioned above. All checked the transcription where possible (some students who had difficulty reading opted out of this stage; for those I wrote a shortened version).

My first transcripts did not have a systematic approach to the transcription of, for example, pauses and interjections. I then adopted the transcription style of Potter & Wetherell (1987). However, from several of the tapes I also made edited versions to use as reading material with other students (Chapter 10). Transcription is a selective process, reflecting the researcher's goals (Swann, 1994); it is 'inevitably a value-laden and disputed process' (Finnegan, 1992: 198). I opted for listing and timing, but not transcribing, clearly 'irrelevant' sections of tapes (such as a discussion of how to cook fried fish). I hope that this leaves an impression of how much groups felt able to leave the set agenda.

Swann alerts us to

> *a tendency ... to home in [on] certain readily identifiable features:* yeah, 'cos, wanna, gonna, laughin', innit, *rather than to transcribe all pronunciation accurately (Swann, 1994: 41),*

thus risking the use of 'comic strip conventions' to represent certain types of speaker, but not others. In general I have transcribed words into standard English orthography (e.g. *going to*, rather than *gonna)*, but have left varietal features where I judged them important to the discourse analysis. Where several voices are speaking simultaneously or overlapping I have if possible transcribed them; where not possible, I have indicated this. (Appendix 4 gives a sample page showing coding, from the transcript discussed in Chapter 6.)

Audio tape does not record gesture, movement and facial expression (Erickson, 1982). Where possible and where it seemed important I made notes of these and of the arrangement of the room (for example, in the taped discussion of an investigation, Chapter 6).

3.5.7 The use of material from other research

I re-wrote sections of some educators' and researchers' texts as learning materials for students to try out and review (Chapter 2); an example is discussed in Chapter 8.

3.6 Data analysis

My techniques for coding the data were broadly in line with those of grounded theory (Strauss & Corbin, 1990): in each section of data (including reflexive data) I coded concepts, grouped them into categories and from those developed themes; these were then checked against repeat codings of the same data, and informed further data collection. However, an important difference came from my developing interest in discourse analysis. The examples of coding given by Strauss and Corbin (and other proponents of grounded theory) tend to come from situations in which the observer may be a participant but is not an immediate actor; that was not my position.

In Chapter 2 I outlined interest in discourse theories and critical discourse analysis within literacy studies (Fairclough, 1992b); these have influenced my own analysis.

A strength of analysis based in theories of discourse is that it offers a structure for considering power relations. Much of the data, for instance, is apparently about matters entirely irrelevant to maths education: for example, in a post-conference discussion (Chapter 9) a shooting in Brixton was compared to the murder of Versace. Such matters might however be crucial to the research. They may show students' contexts for education, and for maths education in particular; they may also show either what students consider relevant to the discussion, or an indication of change in group relationships, such that students are 'allowed' to get off the topic:

> *Discourses are about what can be said and thought, but also about who can speak, and with what authority. (Ball, 1990: 2)*

Discourse theories have also influenced the 'writing up' of my analysis. For purposes of discourse analysis sequences of talk need to be seen *as* sequences (Freebody, 1998b): for example, when we talk we provide an interlocutor with an analysis of what they just said. Theresa Lillis cites Deborah Brandt's description of 'pulverising' her data, so that

> *what's left was not so much an individual's story but the essence of a narrative which ... was no longer the individual's narrative (Lillis, 1999: 4)*

For such reasons, I have given extensive quotations from student and student/researcher talk (which indeed sometimes show me misinterpreting (mis-analysing) what a student has said).

Both the research supervisors and fellow PhD students have read and checked coding for some of the data. Wherever possible I have checked analyses with student participants, both through describing to them what I think I have found and asking for their reactions, and by contributing to jointly written articles (Gray et al., 1999; Wilson & Tomlin, 1999). Further, some of the material which I have treated as *data* (for example, Tracy's article in *Global Maths* (Chapter 10) could be described as students' *analysis*: the relationship between the two is complex and fluid).

Throughout the analysis of data I have had in mind the absences and gaps. They are, at least in some cases, highly significant. Some of the activities to be discussed appear very productive; however, some students were not convinced of that and did not take part in them. One student's departure from a course became a subject of group discussion; others have dropped out from courses leaving barely a ripple behind them. There is no point in trying to guess why they left; on the other hand, the impact of the fact that adult basic education students are an unstable population for a research study should be noted. Some of my analyses could not be checked because those students have moved on.

4 Academic literacy, rewriting history and staying at home

A methodology chapter should explain the principles guiding the methods used in the research. Here I want to look back at whether that is what I have done. I will consider:

- academic literacy and rewriting history
- academic writing as exclusion; omissions from the thesis
- staying at home.

4.1 Academic literacies and rewriting history

Academic literacy practices across different disciplines and subject areas are not uniform (Ballard & Clanchy, 1988; Street, 1996). I have tried to learn to swim in the discourses of PAR, NLS, discourse analysis (e.g. Gee, 1996), wider notions of discourse (e.g. Foucault, 1979), mathematics education, ethnomathematics, ethnography ... These form an overlay on my own prior experiences. As I read I tested out new ideas against both my own experience and knowledge and the research data; so for example my fieldnotes record my arguments or agreements with my current reading. Thus new discourses form part of my development and how I thought about the research.

However, much of the literature discussed in this chapter was suggested to me *because* it was relevant to my approaches to research. It did not 'guide' the research; rather, I am using it to justify approaches I took. So for example I knew I wanted to frame the thesis in research episodes rather than arrange it thematically, and Hymes (op. cit.) justifies this position; in writing as though Hymes (say) 'guided' my methods, I am in effect rewriting history.

4.2 Academic writing as exclusion; omissions from the thesis

One of the central ideas motivating the research has been the active involvement of students. I have described above efforts to keep the thesis as accessible as possible to non-academic readers. The framing of the thesis necessarily (because of the rules of the discourse) includes writing about my own background and that of the field (Chapter 2) and this chapter on methodology. This has three effects:

- 'reflexive' feels like a synonym for 'self-centred'. Despite the deliberate and consistent involvement of students in the research, they sometimes fade into the background in this thesis;
- students are at risk of exclusion from reading a text which is based on their own work - that is, the ethical stances claimed for the work (cf. Cameron et al. and Hymes, above) are rendered dubious;
- in response to the word limit I have had to exclude some episodes altogether. Some students' work will be omitted, not because there are no lessons to be learned from it, but because the thesis framing took the space. The account may be less persuasive because there will be fewer instances of sources for my conclusions, so the impact of the episodes which are included may also be weakened.

4.3 Staying at home

Hymes identifies the move from the local and parochial to the general public sphere: 'the often told journey to the city, or the larger city' (Hymes, 1996: 116) - a metaphor for my own endeavours to shift from story-telling ABE tutor to thesis-writer. This points up

> *a major dilemma of our society: success in technical, professional fields is defined in such a way that someone cannot both stay at home or return there, to serve, and feel successful. This is a major problem for persons with strong ties to their communities of origin, such as Native Americans. (ibid.)*

This triggers for me an anecdote about the value of the oral exchanges of theory and practice from my own 'rural' (non-academic) past.

I used as reading material for an adult literacy group an extract from Benjamin Franklin's account (in *Remarks concerning the Savages of North America*) of the Six Nations rejecting an offer of college education for the chiefs' sons at the whites' expense. Hymes' comment reads as a generalisation about a culture that is not his own. The students applied the Native Americans' story to their own cultures (Jamaican and St. Lucian). In Franklin's account, the chiefs of the Six Nations said:

> *We have had some experience [of your education; when our sons came back to us] they were bad runners, ignorant of every means of living in the woods, unable to bear either cold or hunger, knew neither how to build a cabin, take a deer, nor kill an enemy, spoke our language imperfectly, were therefore neither fit for hunters, warriors, nor counsellors - they were totally good for nothing.*

The Native Americans offered to reverse the colonial teacher/native student roles: to educate the sons of Virginian 'gentlemen' and 'make men' of them. Ruby commented:

> *The Indians should take the offer, for they want to read and write. It is right and wrong, for they could not kill an animal, or speak their own language. They were maybe afraid that the whites were going to hurt them. It is their country. Some people now who come over here for their education, stay here, and do not go back, and some of them go back to help the others. I think everybody should go back in time to come. Get some experience of life, and go back.*

The Virginian whites rejected the Native American counter-offer. One of the aims of this research has been to accept education from students; I hope this 'city' writing will allow the students' stories to 'stay at home ..., to serve, and feel successful'.

Chapter 4: Cindy and Paulette discuss their maths diaries

1 Introduction

This chapter is about an 'interview' (though, as I discuss below, that may not be the right word) about writing maths diaries which marks a turning point in the research reported in this thesis. The story concerns Paulette and Cindy, who interviewed each other, in my absence, using my questions. I had been gathering data, as outlined in Chapters 1 and 3 and Appendix 1, around questions relating to the functions of writing in ABE maths classes, and I expected their 'interview' to contribute to that. And so it did - but not in the ways I expected.

As a result of this 'interview' my confidence in my view of myself as a radical tutor was rocked. Cindy characterised my teaching as *wishy-washy.* Listening to the tape pushed me from analysis of 'writing' to discourse more generally, which, because it includes authority relationships, would be more useful in addressing overall questions of voice and empowerment. It also forced me to recognise that I had been assuming that through my own pedagogic practice I could change students' relationships to maths itself. The students in effect started for me the process of formulating ideas about the relationship of students' epistemologies of maths to their experiences of pedagogy, and pointed to the power of dominant maths discourses.

The interview also challenged my methodology. I had a rather abstract understanding that the researcher's presence impacts on the data - that we never see the world as it would be without us there. As I discuss below, since I was to listen to the tape, I was not entirely 'absent' from its making, but what Cindy and Paulette said astonished me; they gave evidence of feelings and experiences of which I had no inkling. Thereafter I worked harder at making space for students to talk without me, to make their own research questions, and to refuse their participation in the research.

So the interview led me to change the course of the research and introduced key themes. Here I discuss its context and discursive framing, before going on to the themes. These are grouped as students' comments on writing mathematical diaries, with my own commentary relating the interview to my reading of their diaries and a comparison to some of the claims made for mathematical diary writing; issues relating to views of mathematics and maths pedagogy, illustrated with a classroom exchange; and issues relating to the conduct of research. Finally I draw out the implications for the overall thesis.

2 Context

First, some context for the interview. Paulette and Cindy were students in a Basic Maths course which met once a week; the work discussed here came at the end of their second term. Though they were not exclusive of other people, they consistently chose to work together on their maths, checking each other's work and sharing their working; they also set mathematical questions for each other. They were important to the dynamics of the group: listening, contributing, taking risks, offering opinions and sharing difficulties. Through the course they became friendly and saw each other outside the course too.

The students usually wrote a 'diary' entry at the end of each class. We occasionally used the diaries as a starter for group discussion, but in general they were read only by the student/writer and me. The diaries were very varied in content and style. I asked the students to read and discuss each others'; my aims were both to enable the students to get some idea of the range of approaches and styles that are possible (for example, Clarke, Waywood, & Stephens (1993) and Marks & Mousley (1990) discuss genre in students' mathematics writing) and to gather data for my research. Paulette and Cindy said they were happy to discuss their diaries with a tape running; two others looked doubtful; one said I should go ahead, but she wouldn't speak. Only two students (not Cindy and Paulette) came the following week. I had hoped I had made it clear to all the students that if they didn't want to take part in a taped discussion, they needn't. I knew however, that we might have different views of that negotiation: my notes said,

> *No messages. Last week [i.e. maths content] too difficult? Prospect of taping?*

I decided to ask Paulette and Cindy to interview each other without me; otherwise I would be unfairly reducing the teaching time for students who wanted a less active role in the research. The following week all the students came. I explained my idea to Paulette and Cindy, they agreed it, and I gave them a list of questions and a tape recorder. Paulette returned the next week with the tape, played the tape to the group (discussed below) and remained a regular student; Cindy did not return to the course.

This was the list of questions:

> ***Writing maths diaries***
>
> **Please note**
> These questions are only ideas - you can talk about what you like!
>
> Compare your diaries ...
>
> - Are they different from each other? How? Why?
> - How do you feel about writing the diary?

- Does the diary help you in your maths studies?
- Do you ever read your own diary?
- Is the diary sheet ok?
- Any advice for tutors or other students?

3 The discursive framing of the interview

Before discussing the formal topic of the interview, maths diaries, I will analyse some features of its framing. It is in some ways strikingly formally organised. I will discuss two aspects: questioning, turn-taking, and overall framing; and control of the tape recorder. I then argue that the text gives evidence of an 'unsettling' of discursive positionings.

3.1 Questioning, turn-taking and overall framing

The most striking surface feature of the discussion is the highly organised way in which Cindy and Paulette work through the questions and make sure each has her say. For the first part of the discussion (up to the last of my questions, 'any advice for tutors or other students?') they read aloud my questions and organise who is to speak. For example, Paulette reads out a question and starts answering it:

> *Ok. So how do you feel about writing diary? Well, how do I feel? I find I think it's ok you know because it sort of make you-*

She is interrupted when the telephone rings, and there is a break in the tape recording. The two organise a return to the exact point at which they broke off:

Cindy:	*How do you feel about writing the diary?*
Paulette:	*How I feel? I feel ok you know because writing the diaries it makes you ...*

They summarise and sign off a turn so the other can take over. Paulette indicates she has finished her turn:

> *Well that's how I feel about writing diary*

and Cindy takes up the question:

> *Well I thought ...*

At occasional points of unsureness they check with each other; for example, Cindy checks what to do next, has the question confirmed, and asks it, in the following exchange:

Cindy	*Do I ask you the same question?*
Paulette	*Yeh*
Cindy	*Does it help you in your maths studies?*
Paulette	*Yeah. My diary does help me in my maths studies because you (.) it's like I keeping a day-to-day record on what (.)you're doing on a daily or weekly basis. Ok?*
Cindy	*Mm hmm*
Paulette	*So, do you ever read your own diary?*

They use the pronoun *you* when quoting from the questions I wrote. Their own framing is much more formal, giving the discussion the air of a radio programme:

Paulette *Ok. This is Cindy and Paulette discussing our maths diaries.*

They talk *about* the other as a third person:

Paulette *Well Cindy's, I think she's sort of get to the point ...*
Cindy *And Paulette just seems to write just exactly what we <u>did</u> in the class, she doesn't discuss her feelings much, whereas I do ...*

This is maintained through the comparison of the two diaries (that is, their response to my first question 'Compare your diaries ...'), in which each initially comments on the other's diary, though Cindy also comments on her own. The next question, 'How do you feel about writing the diary?' leads to first person responses, and each replies for herself. They then stay in the first and second persons until Paulette signs off:

This is Miss Paulette and Miss Cindy doing the recording, on writing diaries. Ok thank you bye bye.

The audio tape makes clear that this is a parody of a Jamaican radio show; Paulette speaks more loudly and deepens her accent. I would like to speculate about the build up to this ending. A few second earlier, Paulette had spoken to an assumed audience of fellow students as she signed off:

I would like to encourage all the other students to try and continue. So, that's all I have to say. So I just wish everybody health and strength and happiness

- an uncomplicated benediction of their academic and home lives drawn, I imagine, from Jamaican community life. She perhaps becomes defensive about this open blessing or toast when Cindy chuckles and mutters 'World peace'. Paulette presses on:

You know, whatever job they're going to go for in the future, I hope that even though this little maths as simple as it might look it might help them you know, in later life.

Cindy then comments, perhaps seeking to withdraw any suggestion she was mocking Paulette's toasting: 'Well said' . Paulette then gives her radio sign-off, confirming that she took the 'world peace' comment in good part. Whether or not this is an accurate reading of Paulette's and Cindy's last exchanges, the effect of the radio sign-off is to present the whole tape as a neatly framed radio programme.

3.2 Control of the tape recorder

There are two points at which the tape is turned off: when the telephone rings, and then when Paulette reads out the question 'Any advice for tutors or other students?' It throws Cindy:

Golly, um (3) I don't know. Um, what do I think, about that? (1) Help me, have you got any advice for tutors or -

and Paulette takes over:

> *Tutors or students, what do I think? (2) Well I think it's important (.) to keep coming ...*

Paulette goes on to address issues of attendance (discussed below). At the end of that section, the tape was turned off and restarted. It seems likely they turned the tape off to enable them to decide what to go on to; as we have seen, they structure the discussion very clearly, and after Paulette's contribution on this question, they needed to revert to Cindy's, which was not ready. When the tape is restarted, Paulette discusses the possibility that students would avoid this taped discussion (discussed further below) - so she raises questions of tutor or student control and direction. Cindy denies it is a problem:

> *Anyway I tried to convince Paulette that it wasn't true that I deliberately missed last week because of the recording but she won't believe me*

and it seems that this was discussed while the tape was off. Then Paulette formally invites Cindy to speak:

> *So, Cindy would like to talk about (.) how she feel about, you know, her studying and .. what she would like to achieve at the end of each lesson, so go ahead.*

Cindy then presents a critique of the teaching (section 5, below), which is her answer to the request for advice for students or tutors. This contributes to the balance and formality of the discussion: Paulette has given advice to students, and Cindy to tutors. Paulette's introduction to the section makes it clear that they have discussed what Cindy would say while the tape was off. They take control of the interview process, turning their hesitation when faced with an open question into an opportunity for doubts about the processes from Paulette and a critique of the course from Cindy.

3.3 Unsettled discourse

The students' diaries are written; the taped discussion was spoken. But the borders are very fluid. The discussion was framed around questions that were written down, and those questions, reappearing as curiously neat, formal sentences in the oral discussion, define a 'written' feel to it. The framing as radio programme, generated by the students, gives a scripted feel, even though it comes (I suspect) from playing with a Jamaican tradition of formal public speechifying. The students' editing of the discussion, by turning off the tape, gives their discussion an element of planning and control over timing and content that are usually not available to interview subjects. (There is only one real hesitation, Cindy's 'Golly, um [3 secs. pause] I don't know. Um, what do I think, about that?'; it is this that leads to the students' taking editorial control.) These considerations lead to my hesitation about calling this an 'interview'. I take genres to be particular text types arising from social configurations and purposes. Here both are unsettled and perhaps because of this the interview does not 'fit' a settled genre.

In a research interview the researcher can control analysis, interpretation and distribution of the text. This may be adapted - for example interviewees may put limitations on distribution and demand anonymity - but essentially the text is owned by the researcher. For example, I shall be discussing here Cindy's comments on my teaching; I could have omitted them. Paulette's playing of the tape put it into a shared arena - she in effect owns and can distribute the text. James Gee distinguishes between *Grammar one* (traditional school grammar) and *Grammar two*:

> *patterns [through which] interpreters can attribute situated identities and ... activities to us and our utterances. (Gee, 1999: 29)*

The 'grammar two' of this text is complex, and challenges interpreters' initial information that these are 'students in a basic education class'. The students represent themselves as knowledgeable (about their own and others' learning, and the nature of maths); confident (able to give advice); able to play ironically with multiple discourses. My purpose was to gather data on diary-writing; their purposes include, as we shall see, improving their class.

4 Writing and reading maths diaries

4.1 How are the diaries different from each other?

Paulette and Cindy first discuss my question 'Compare your diaries ... Are they different from each other? How? Why?' Paulette says Cindy's 'sort of get to the point':

> *[Reading from Cindy's diary:]* 'Last week we did perimeters and areas'. *You know, as she said she was quite pleased because she did get her work right, this week. So why, (.) obviously yeah because (.) she's finding that she can work it out.*

But my 'why?' was intended to be about the writers' purposes, not the mathematical content. Cindy's responding 'Mm' when she hears Paulette's comment sounds slightly doubtful. In commenting on Paulette's diary Cindy talks also about her own:

> *Paulette just seems to write just exactly what we did in class, she doesn't discuss her feelings much, whereas I do, I'm sort of always saying whether I felt pleased or I felt (.) bad or whatever (.) It [Paulette's] reminds me much better what we actually covered than mine do, I think.*

This marks out two possible functions of keeping a maths diary: a) recording issues to do with studying maths, including emotional reactions, and b) recording technical issues and procedures learned. Cindy's diary is full of the former (these quotations come from different entries):

> *Got a bit panicky .. felt the numbers were beginning to swirl ... Felt deflated - but then that's why I'm doing the course isn't it?*
>
> *Still feeling confident ... I felt pleased... not baffled.*
>
> *I got mixed up ... I feel quite happy ...*
>
> *Felt rather deflated - either things are too simple or too complex.*

> *Basically my maths is wrong ... So I'm going to have to ask Alison more.*

Paulette's diary includes some indications of emotional reactions, for example,

> *It was brain rattling and challenging.*

However, her diary is dominated by specific mathematical information and procedures. This is her full diary entry for one class:

> *Today we did areas. For instance square centimetre into metres. Did some rectangle shapes with squared boxed diagram 2 x 2 = 4 squares 2 cm^2 also doing practical work e.g. to make curtains for a window 250 cm wide and 150 cm high, the material sells by 1 metre wide. How much would you need to buy to fit this size window. So you work it out finding out how many centimetres made a metre which is 100 cm = 1 metre. So 250 cm = 2$^1/_2$ metres and so on. But for me to work out centimetre to metre conversions can be a bit tricky, or weights or distance. So I need to do more conversions to feel confident.*

4.2 How do you feel about writing the diary?

From this point onwards, it seems clear that although Cindy says she values the diary now that she is asked to comment on it, in practice it has more use for Paulette. Paulette describes how she feels about it in terms of reflecting back on her work:

> *I feel ok you know because writing the diaries it makes you can reflect back on what you're doing right or wrong .. and it's sort of like a memory thing but it's only that it's written <u>down</u>, and it's something that you can refer back to later on, and(.) you can use as reference.*

This use of the diary as a reference text is consistent with her inclusion of procedures and facts she is learning. By contrast, Cindy says

> *My heart sank a bit and I thought, what a waste of time. <u>But</u> I <u>can</u> see the point in it now, only in that, you know, over the weeks you <u>do</u> begin to get a picture of what you <u>have</u> covered and it does jog your memory a bit and you begin to remember what you were good at and what you really were hopeless at.*

This is a different kind of memory: not a maths reference text, but a record of your successes and failures. This makes the last entry I saw from Cindy even more poignant:

> *Basically, I think my maths is wrong. I calculate things incorrectly.*

4.3 Does the diary help you in your maths studies? Do you ever read your own diary?

Paulette's and Cindy's abbreviated responses to the first of these questions may indicate the poverty of the questions I gave them. I had intended them to be pointers to a discussion; I *meant* what I said in the preamble, 'These questions are only ideas - you can talk about what you like!' However, the questions are 'closed': they invite yes/no responses, and probably imply that 'yes' is the hoped-for response. Paulette and Cindy had in effect covered whether the diary helped in their maths studies by the time they reached this question. On the other hand, it gave space for Cindy's response:

> *To be honest if I hadn't been doing this today I wouldn't probably have read it.*

Paulette says, confirming her earlier description of the diary as a reference text,

> *My diary does help me in my maths studies because you know (.) it's like I keeping a day-to-day note, or record, on what (.) you're doing on a daily or weekly basis.*

Their comments on whether they read their own diaries are consistent with what they have said so far, but with the addition of an overtone of authority and/or morality. By the time Paulette asks if Cindy ever reads her own diary, they have already agreed the value of the diary, and Cindy has both claimed it is useful, and admitted she would not have read it if this discussion hadn't been planned. Cindy gives a mock defensive reply,

> *No. I will, you know, I will*

delivered in the tones of a child defending herself from being told off. The emphasis in Cindy's repetition of the question for Paulette is challenging, and Paulette responds with an assertion of her correctness and an admonishment to others:

Cindy	*Do you ever read your diary?*
Paulette	*I always read my diary! [both laughing]*
	I think, yeah, because sometimes you know, even well we do make mistakes and you know I think we should (.) should go over our own diaries.

This gets only a 'Mm' from Cindy and they go on to the next question.

4.4 Is the diary sheet ok?

They are not sure what this question means:

> *I suppose she just means is there enough space. (Cindy)*

I meant something wider than that, to include whether the questions at the top of the sheet were helpful, adequate, and so on. Adopting Cindy's interpretation of the question, Paulette suggests there may *not* be enough space:

> *You can always go down to the next [section]*

and in fact her last entry before the discussion (quoted in full above) took two full sections. Cindy briefly agrees, but goes on:

> *It's quite nice knowing that you don't have to go any further. I wouldn't like to have to write reams of it, would you?*

This comment is built on some assumptions. One is that you have to fill the space - by implication, if the space was bigger, you would have to write more; how much you write is defined not by what you feel like putting, but a teacher-defined space. Another is that the space is at present small ('is there enough space?'); Cindy has no technical problems with writing, and I suspect others with reading and writing difficulties may feel the space is an uncrossable desert. The third assumption is that writing the diary is compulsory: you 'have to' write it.

4.5 Implications for using diaries in maths teaching

Paulette and Cindy identify important differences in their writing and use of their diaries. There are some issues raised which are worth pursuing and clarifying; extracts from the transcript appear in *Global Maths* (Chapter 10; Appendix 10) and have been used in other groups to start off discussion.

The question of layout of a diary worksheet is important - for example, frameworks may constrain writing (Taylor, 1995). Tutors influence the outcome of students' supposedly free writing by our judgement of what is 'scaffolding' and what is unfair constraint. One of the students in the same group was triumphant when he 'got to the end' of a page (Appendix 1). This relates to the notion of developing genres of diary writing. I had hoped the students would consider not just space, but my questions. Other 'scaffolding' is available in the literature (e.g. Rawson, 1996) and we could perhaps try out different frames for writing. I would suggest that groups could critically discuss a range of 'frames' and select their own.

Most published theory about the value of journal or diary writing within mathematics suggests that it promotes a constructivist view of mathematics and helps students (predominantly children, in the literature) see themselves as creating maths. Much also divides the 'benefits' to be derived from the diary writing into two groups: those for students, and those for tutors.

I have great difficulty in relating the data from this transcript and my own notes to the theoretical literature. For example, since Cindy doesn't put 'straight' mathematics in her diary, and anyway doesn't read it, it is unlikely that it helps her 'remember' mathematical results or procedures, a claim made, for example, by Powell and Ramnauth (1992); on the other hand, Paulette strongly agrees with them.

What does 'diary writing' mean? Some of the literature identifies exactly what is meant by diary writing. For example, Clarke, Waywood and Stephens (1993) report on using students' diaries as an assessment tool, within a highly structured and teacher-defined framework. A report from Borasi & Rose (1989) is frustrating in that it seems the students were given a framework for their diaries, but it's not clear what it was. Barbara Schubert gives detailed examples; her questions include:

> *Journal entry: Write what you would say to another fourth grader to describe a fraction. (Schubert, 1987: 349)*

but also suggestions towards more informal and personal writing. Some of the literature is much less specific on what a 'diary' is. I would argue that 'mathematics diary' is not of itself a genre; it is used for different social purposes (from entirely personal reflection to formal assessment; from records of personal struggle to formal recording of a newly learned algorithm) and has a wide range of styles. Within one class, of about eight students, using the same diary sheets with the same suggested questions and the same amount of 'space to fill', these two students may be working within two different genres; one is akin to a personal diary, and one to a mathematics notebook or textbook.

From the data here, from two students' diaries and commentaries on them, I cannot come to a general conclusion about the value, or otherwise, of particular forms of maths diaries. However, I suggest that the data here shows the value, certainly to tutors and thence to students, of critical discussion of the forms and purposes of maths diaries - that is, critical analysis of the discourse of maths classrooms.

5 'Any advice for tutors or other students?' Views of maths and pedagogy

Although the interview was 'about' diaries, Cindy and Paulette also commented on the pedagogy and on fellow students' attendance.

My last question was 'Any advice for tutors or other students?' Cindy used this opportunity to criticise the teaching, though with Paulette's encouragement she pulled back and moved into praising it.

The notion of 'correctness' in mathematics had been introduced earlier in the interview, when Paulette said Cindy was pleased with her work:

> *So <u>why</u>, (.) obviously yeah because (.) she's finding that she can work it out, you know (.) getting to the correct <u>answers</u>.*

Cindy then presents a traditionally right/wrong view of mathematics, in terms of her own achievements:

> *you begin to remember what you were good at and what you really were hopeless at.*

In giving advice to tutors she extends this right/wrong view in terms of the structure of mathematics itself:

> *I've <u>very</u> much enjoyed the course, as I've said, but (.) you know sometimes I just think it's a <u>little</u> bit <u>wishy-washy</u> that you can, you know, you sort of get (.) um, told that you've done very well because you're <u>almost</u> right, or you're on the right tracks. But I mean in <u>maths</u> you're either right or you're wrong, <u>I</u> think, and (.) you know, it's not (.) I just wish that it was more (.) um, (1) you were <u>told</u> that you had,*

> *you know, that you had got it right, or you had not got it right, and there's no sort of oh, well done anyway, it doesn't really matter (.) Because that's how I feel, oh well, it doesn't really matter, but you know, it's <u>kidding</u> yourself in a way, you want to get it right and know that you <u>can</u> do it right.*

What I perceive as examination of the detail of a student's mathematical thinking, which may lead to comments like 'you're on the right tracks', is seen by Cindy as encouraging her to kid herself and in effect denying her the opportunity to know 'that you <u>can</u> do it right'.

This discussion is deflected by Paulette's intervention:

> *So is there something else you would like to learn more of, to get more confidence in, or whatever.*

Here Paulette is addressing questions of the curriculum, rather than the teaching, and Cindy concedes,

Cindy	*No I like what we're doing, I think it's good that we've all sort of [(written on this)*
Paulette	*[and the measurements and the [conversions*
Cindy	*[Yeah, and I think you know actually one is learning more than you realise in lots of ways because, you know, about kilos and things like that, that's what's been bothering me about when you (.) you <u>have</u> to go to the supermarket and be able to say what you want. But you know, in fact, I'm getting used to it, and if I can <u>only</u> remember that a <u>hundred</u> centimetres is one metre, well, [both laughing] I reckon I've done really awfully well!*
Paulette	*So you would say you <u>are gaining</u>*
Cindy	*[Yeah*
Paulette	*[as much as you know*
Cindy	*I think so*
Paulette	*More than what you thought that you probably would. Because you know I like to learn <u>more</u> when it come to practical things, I mean just like the conversions, I mean, alright, I don't really look at, when I go into the shop and say well, you know, there's a thousand gram in a whatever, pound or whatever, I just pick up what I normally buy, [you know*
Cindy	*[Yeah, but it's only if you go, say, like the delicatessen section, and they ask you how much you want, and I know <u>exactly</u> in pounds and ounces, but I don't have a clue, well I'm getting better actually =*
Paulette	*= Yeah, so, ok, so. So going to (.) the college and learning <u>about</u> these conversions, it has helped.*
Cindy	*Yeh, I would say so.*
Paulette	*[Day to day.*
Cindy	*[Definitely.*

This is not convincing. Cindy's earlier statement about wishy-washiness and kidding yourself has all the force of something considered in advance (as it was, when the tape was off); this later exchange pulls back from the edge of criticism of the teacher and class, and is pushed by Paulette. Paulette's linking of learning mathematics with gaining confidence in it is confirmed when she prompts Cindy:

> *So you would say you are gaining as much as you know, more than what you thought that you probably would.*

Cindy does confirm the relevance of the curriculum in terms of her shopping needs, but that is not in conflict with her view of the teacher's stance. She sees O-level as her goal, speaking of it wistfully as a far-off possibility:

> *I would love to get my maths O-level but I don't ever know, I mean I was just so hopeless at maths at school. (1) I just think it's probably not possible.*

Paulette goes on to introduce praise of the teacher in terms of gaining confidence:

> *I think, you know, me going to college and you know, feeling the confidence that I do have, right now, is because of the teacher. I think that makes a big difference.*

That 'confidence' is a two-edged sword. Cindy responds also praising the teacher, but in terms of her own inadequacy. What she had earlier called 'wishy-washiness' is explained as pulling back from condemnation of poor students:

> *Yes and maybe that's why it's (.) she is the way she is, you know, she never sort of says Oh you stupid idiot you've got that all wrong. I mean what would be the point, you probably would not come back if that was the case. And it is only Basic Maths after all, it's not perhaps at this stage all that important.*

So Cindy's view is that the teacher may not apply the true standards of absolute right/wrong to maths for beginners; the subject has to be distorted for basic level students.

Paulette, unlike Cindy, positions herself socially and relates her maths to social demands (note too that although Cindy (above) agreed metric measurement was a use of maths, it was Paulette who had first mentioned it):

> *Us being adults and having children of our own and you know, feeling inadequate when our kids come home and we're not able to help them and (.) going back to college and having the right teacher, and being in the right atmosphere, and you know, company or whatever, it does help a lot, (1) because when you feel like you're in the winning team, you know, I mean just like me, I'm generally a quiet person, you'll never believe [laughing] but because of the confidence that I feel, from the teacher and from the other pupils ...*

She sees her mathematics studies as a social endeavour, both in terms of social use value and learning in a group. However, she doesn't challenge Cindy's assertion that mathematics is right or wrong.

Paulette identifies a 'team' as contributing to her new-found confidence in her mathematics ability. In fact attendance had been erratic, and she uses the opportunity to give 'advice' to students, as part of her response to the last interview question:

> *I think it's important to keep coming and not just come like once every month or whatever, because, you know, you do keep up with whatever you're doing in life,*

> *you know. You know if you don't keep up you forget. I mean you might do perimeters this week, next week you come we're doing percentages and you miss out so much. So I think (.) once you do start into college or whatever you might be doing, you must take it seriously and try to keep up you know with your studies, so you're always ahead, and instead of feeling left behind or whatever, and then you know you gain confidence when you go to college. You're meeting people, exchanging thoughts and ideas, and you know, when you go to work it's more or less the same thing, so I think it's good to keep up with your work or whatever.*

So mathematics study is associated with 'whatever you are doing in life' - a serious endeavour; it is similar to work in 'meeting people, exchanging thoughts and ideas', and I think it is implied that regular attendance at college will help with adjustment to work (all the students in their group were unwaged); these comments are strikingly similar to views expressed at the later students' conference and in the magazine *Global Maths* (chapters 9 & 10). It can be read too as suggesting Paulette thinks some people attend erratically *because* they are 'feeling left behind'. Above all the seriousness of her tone tells us she does indeed see herself as part of a team; she is asserting her right to speak from experience to people she wants to help (and looks beyond Cindy's 'we're all in this together').

The students' common-sense view of mathematics as a subject with clearly right and wrong answers is unchallenged; mathematics is seen as a fixed, factual subject, with a variety of possible teaching approaches attached to it.

My own responses in the classroom

In the following class, after I had listened at home to the whole tape, I heard myself saying, it seemed constantly, 'well you're nearly there', or 'it should have worked'. As we went through some weights work on the board, Marguerite converted 5 kg to pounds by multiplying by 2.2, and got 10.10 (which she read as 'ten point ten'). I paused and thought about what to say, and said no, it was 11, and showed the calculation. Marguerite said 'Well it was nearly right'. She was saying that 10 is about the same as 11, and she's right: 5 kg of potatoes is about 10 lbs. My heart sank, though, as I recognised that I *don't* think 0.2 x 5 = 0.10 is 'nearly right'.

I stopped and explained to the group what had been on the Paulette and Cindy tape, and why I had said 'no' to Marguerite; we had some discussion about it, though Cindy was not there to present her perspective.

During the course I had mentioned historical sources and solutions from different cultures; I raised questions of the naming of numbers (in various languages) and their relation to place value; people explained and discussed their mental methods; the group would consider what methods would be best in particular contexts; they set their own problems. But all this had been perceived not as an approach founded in my understanding of mathematics, but in my perception of the students' limitations.

I now see that this is not surprising: I and the students are working in a society in which the dominant discourse holds, as Cindy says, that in mathematics you are either right or wrong, and in which failure in school mathematics is one of the greatest blocks to other progress in education and employment. I do avoid saying 'You've got that all wrong'; I agree the students 'probably wouldn't come back'; I agree some 'feel inadequate'. However, my ambivalence about judging students' work as wrong arises from a mix of pedagogical factors. One is the need to generate confidence (as I discuss below); but the other is based in the mathematics, and derives from my assumption that there is some mathematical thinking behind an error (as argued by Alrø & Skovsmose, 1996).

Cindy's and Paulette's analysis of the classroom engages with the relation between curricular and pedagogical questions and the nature of mathematics. Whereas I assumed my curriculum choices and pedagogic stance implied a view of mathematics as a social construction, they were understood by Cindy as patronage. That reading was related to her view of maths as 'either right or wrong', hence she interpreted my teaching as confirmation that her skills were poor. I had hoped I was supporting a classroom culture in which students' own ideas and methods were valued; the effect (for Cindy, not Paulette) was to devalue them. Borasi and Rose (1989) say writing mathematics journals leads to development in beliefs about mathematics, and Clarke, Waywood and Stephens (1993) say journal writing facilitates

> *the construction and sharing of mathematical meaning and promote[s] student reflection on the nature of the mathematical meanings they are required to communicate (236);*

it hasn't, for these students. I suggest that we need to incorporate discussion of the nature of maths and pedagogical models overtly into the curriculum, if we are to avoid this potentially damaging confusion. In this group, hearing the tape precipitated me into an abrupt change in teaching practice, which was challenged by Marguerite and led to group discussion. One way of developing resources for this kind of agenda is through using such texts as starting points, hence the inclusion of edited sections from this transcript in *Global Maths* (Chapter 10; Appendix 10).

6 Authority and the conduct of the research

The interview gives some evidence of how Cindy and Paulette see the tutor's authority in the classroom. Students felt they were a 'team' and were not unduly nervous of the teacher; in particular, Paulette and Cindy are remarkably confident and articulate. Despite this at least one, Cindy, felt some element of compulsion about completing the diary. This needs further examination. We could argue that all the basic elements of a mathematics tutor's lesson plan are 'compulsory', in that if a student attends a class she is committing herself to co-operation in the project. Cindy doesn't see the diary as an integrated part of a mathematics class, and she's right: most classes don't require it, and I wanted a taped discussion about it *because* it's 'different'. This is close to the edge of a student feeling compelled to take part in the research project. Put together with a discussion about avoiding taping, we have a picture of a group of adults willing to go along with their tutor's project, rather than a group of 'participant action researchers'.

Paulette suggested students stayed away from the course in order to avoid taking part in a taped discussion:

> *Yes, I had to laugh when I was at college the other day .. well I didn't come to college because you know I had a bit of flu, but it seemed that most of the students never came, because of this recording or taping that we're doing right now actually. So funny enough, when we were ready to leave [the following week], the teacher says, Erm, excuse me Paulette and Cindy, but we haven't been able to do any of the recording, could you two girls volunteer? [Cindy laughs] And I had to laugh because you know Cindy had just told me five minutes earlier that you know, Oh, what happened last week, did I miss the recording? [both laughing] .. I mean that [the taping] doesn't really put me off at all, but you know it was just really really comical, you know, you thinking that we'd missed the recording, so I thought that was quite funny.*

'The teacher' quote is given in a high, teacherly voice; the use of 'girls' may be a reference to school days, or just how Paulette refers to women. Cindy denied that she missed a class in order to avoid the taping, and Paulette found the whole business funny. Nevertheless, uncomfortable questions are raised about whether students are pressurised into giving time and attention to issues they would otherwise ignore. More of the tape is spent on the final 'advice' question than on the rest put together; the students use the opportunity to raise issues they regard as important, and that doesn't necessarily include the issues I had raised.

When Paulette brought the tape into the class, the week after the taping, she said,

> *You can listen to it now if you want to*

thus suggesting the whole group might be interested. We listened to the first few exchanges; however, it was not clear enough for non-participants to follow easily, so only a few minutes were played.

Asking students to conduct their own interviews resulted in some data I would otherwise have no access to. I doubt whether Cindy would have raised the 'wishy-washy' criticism had I been there, and if she had, I would probably have responded by outlining my own perspective. Had Paulette told me other students should attend more consistently and try harder, I would have defended them. I have much less information about the original questions I asked, to do with diary writing; had I been the interviewer, I would have been using 'active listening' techniques, allowing silences, probing, and so on.

Much of the research I have read in the area of maths diary writing (some is discussed in Appendix 1) is either conducted by an independent researcher or by the teacher, or the two combined. Both have obvious drawbacks: for example, an independent researcher will have little background knowledge; a teacher's personal and professional authority may distort students' responses. In an attempt to work jointly with student co-researchers I think we have invented a third relationship for the teacher/researcher and students, in which I am both present as past questioner and future audience, and absent in body and voice. My absence made it possible for the students to say things they otherwise could not; apart from anything else, it silenced me. The tensions this produces for me are obvious throughout this chapter. For example, I veer between calling myself 'me' and 'the teacher', reflecting Paulette's and Cindy's usage of both 'the teacher' and 'Alison'.

7 Summary and themes

The 'interview' between Paulette and Cindy contributed to a change in the direction of my research. Here I draw out the themes which will be taken forward to Chapter 11. I consider methodological issues; epistemology, curriculum and pedagogy; texts, discursive practices and unsettling discourse; and confidence in maths classrooms.

7.1 Methodological issues

Working on the text confirmed for me the value of readings informed by discourse analysis (e.g. Fairclough, 1992a; Gee, 1999) - though, as elsewhere in this thesis, I have not used the full range of analytical tools. Discourse analysis seeks to unpack the practices behind the apparent texts - to 'explore the opacity' of relationships within and between discourses (Fairclough, 1992b: 133). The combination of 'content' - the apparent text - with other elements (for example, tape recording and playback control, or the 'radio script' feel) has generated more data than 'content' alone, and it is data that informs my wider question relating to student voice.

Students' collecting data introduced areas for research which otherwise would have been missed. This is not participant action research (Chapters 2 & 3) (as we have seen, the participants may have been reluctant, and the initial research questions were mine). However, this episode forced me into direct and personal, rather than theoretical, recognition of the impact of my own presence or absence. All the data collection and analysis after this episode was informed by students' more active, creative involvement in the research and by discourse analysis theory. The 'interview' therefore changed the development of the research, and offered pointers to productive ways of both working in and researching adult basic education.

7.2 Epistemology, curriculum and pedagogy

As a 'radical' maths tutor (Chapter 2) I closely associate a critical view of 'standard' maths as a dominant discourse with a view of maths as socially constructed and therefore open to transformation. The 'interview' shows that my attempts to demonstrate this through pedagogy were not enough; the right/wrong polarity of maths remained unchallenged. So pedagogical style of itself had not worked as a means to critique the dominant discourse. Indeed, it is tutor-centric, depending on the tutor's dominant voice and determined by the tutor's view of maths and maths education.

This is consistent with my interpretation of data discussed through this thesis. As the research progressed I came to believe that if tutors want to raise questions about the epistemology of maths, we must do so explicitly and be open about our agendas. Students are unlikely to suggest discussion about it, exactly because the view of maths as a given, rigidly hierarchical, right-or-wrong, set of facts, rules and procedures (consistent with Ernest's (1991) 'absolutist' position) is so naturalised; students have (generally) come to learn maths, not to question it.

7.3 Texts, communicative practices and unsettling discourse

Here I draw together findings arising from discourse analysis relating to discourse practices in adult basic maths classes. Analysis of the interview, with Cindy's and Paulette's analysis of their diaries, casts doubt on the neatness of the boundaries around elements of discourse supposed in dominant discourses to be the building blocks of pedagogy and learning practices. I first consider the blurring of the boundaries in the notions of writing and audience, and then suggest how these language-in-use issues

(Gee's small d *discourse*) relate to wider issues of unsettling classroom discourse - Gee's (capital D) *Discourse*, including the enactment of specific identities and activities (Gee, 1999: 5-6).

The interview exposed the extent to which my perhaps naive reading of the diaries had led to inappropriate tutor responses. Marwine summarises the benefits to teachers of students' writing within mathematics:

> *Reading what students write permits insights into their own views on the material ... we actually get to hear* what *they are thinking and* how *they are thinking it.*
> *(Marwine, 1989: 59; original emphasis)*

While we cannot assume all advocates of writing to learn maths would agree with this, I think it is a fair summary of most writers' perspectives: writing offers a window on 'the truth'. Given the opportunity to discuss their diaries, these students raised issues that did not appear at all in their diaries: their relationship with other students and the teacher, which raised questions about philosophy of mathematics and mathematics education. Trust in diaries, of whatever sort or genre, as a source of truth, or at least of whole truth, seems then to be unsafe. (In Chapters 6 & 10 I will argue that the analysis of 'writing' practices demands attention to spoken language and/or reading; that is, the notion of 'what students write' is not transparent.)

Cindy and Paulette had no other audience in the room as they made the tape, and I have argued that my absence had a transformative effect on their discussion. However, there are at least four audiences: the tutor/researcher, since they knew I would hear the tape; readers of this thesis, to which the tape was to contribute; the maths group, to whom Paulette played the tape and who later discussed the interview when my hearing of it changed my teaching responses; and the readership of *Global Maths* (Chapter 10), which includes an edited version of the transcript. The tape includes different personal discourses (Paulette's authoritative 'classroom' voice in her advice to students, her 'Jamaican radio' framing of the overall discussion, and her quoting of my questions, for example) - so this is a text which addresses different audiences, in different voices, but without a consistent relation between voice and audience. I have not found this subtlety, control and flexibility in students' texts addressed in research on ABE.

The interview, with the jolt to my own practices as tutor and as researcher and the discussion in Paulette's and Cindy's own group, had an effect I have come to think of as 'unsettling the discourse' (taking 'unsettling' from Ellsworth (1992), discussed in Chapter 2). If we aim to strengthen students' voices then we need as much flexibility as possible in how and to whom those voices can speak. A key factor in gaining that flexibility is making space for students to speak to and hear other students (to which *Global Maths* contributes). Another factor is making some tutor-free space for students. This is not to suggest that we should silence ourselves in the classroom - indeed, Cindy argued that I should be a stronger voice for 'correct' mathematics, and in Chapter 5 I present the views of some other students that I, as class tutor, was and should be 'dominant'. However, if we seek to empower students then discussion of classroom discourse - wishy-washy or dominant tutoring, consistent or erratic attendance, the value or not of diary writing - must be shared with students, not held in the tutor's head. The relation is reflexive: strengthening students' voices involves unsettling classroom discourse, including the tutor's voice; and unsettling the discourse makes space for students' voices to be heard. I suggest that here the key starting point was my question asking Cindy and Paulette for 'advice'; they were positioned as experts rather than learners. In the following chapters I discuss episodes from the research in which a key starting point was to see students as researchers.

7.4 Confidence

Linked to questions of curriculum and epistemology are questions of measures of success. A consistent theme in this thesis is students' measurement of their progress in terms of confidence. There are two ways to focus here, using the interview and Cindy's diary.

Firstly, confidence in what? The interview shows Paulette and Cindy to be 'confident' women - able to give advice, play with genres, analyse their class and control their communication with the teacher and students.

Secondly, Cindy's diary had shown her to be unconfident in maths; my pedagogy was intended to improve her confidence, and I signally failed. There is no sign in her diary entries that her confidence was improving; the evidence of confidence in the tape is pushed by Paulette, not Cindy; and Cindy disappeared from the course (many students in AE drop out; here I feel, perhaps wrongly, that her critique of the course and her disappearance are linked).

These two views together suggest that 'confidence' depends on the discursive setting. This is a challenge to the Freirean view of students' 'culture of silence' (Chapter 2): it appears rather that 'silence' may be generated by the adult education discourse that is supposed to strengthen students' voices. This is consistent with my interpretation of other stories from the research, and will be one of the central findings reported in this thesis.

Chapter 5: Observing ourselves

Introduction

In this chapter I discuss observations of and on their classes undertaken by an evening 'Basic Maths' group. I shall argue that the observations and group discussion of the data which was collected led to an unsettling of classroom discourse, with open and critical discussion of students' and tutor's discursive positionings.

The group met once a week for two hours; these sessions took place over seven weeks in the third term (so the students knew each other well): three in planning, two observed classes, and two in which we discussed our findings.

Nine sections follow: the background; my proposal; the observation schedules; the observed classes; collating the data; sharing results; what we learned; a commentary on research practices and discursive shifts; and a summary to draw together themes for the overall thesis.

1 Background

For a Handling Data unit (Open College) students had to *collect data by questionnaire and observation.* Collecting data is often seen as a way to bring the 'real world' or 'everyday life' into the classroom, and past projects, chosen by students, include inquiring into perceptions of racism in school among black teachers (at the student's child's primary school); an investigation into the fall in burger sales during the BSE crisis, by a student who worked at Macdonalds; and a collaborative group comparison of supermarket prices. The notion of a 'real world', outside of the classroom, is further explored later in the thesis; this chapter discusses examination of the real world inside the classroom.

When I introduced the collecting data unit only one person, Carol, showed much initial interest in it. She was taking a course for school learning support assistants, and was interested in observing the behaviour of children in the playground. There probably would have been ways to cajole the others into identifying data collection projects they could undertake; apart from anything else, success in the unit requires data collection. However, the group had been particularly open in discussing the teaching and their own ways of working and I was reluctant to engage in 'encouragement'. The group's openness in course negotiation arose from an episode which had led to group discussion of how the course was going, and re-negotiation of the course plan (including the decision to do the Handling Data unit). (Negotiating the curriculum will be discussed in Chapter 11.)

2 My proposal

I proposed that we observe ourselves. I had no very clear plan or structure in mind, both because an over-riding concern was to ensure that genuine dissent was possible, and because if the group did agree to the proposition, any prepared plan might limit their control of the process more than would otherwise be necessary. I made the suggestion towards the end of one group meeting. I included these points:

- the proposal was in many ways a selfish one since it would help me as much as the students
- I gave examples of data collection projects undertaken by other students. I stressed that we could almost certainly work out plausible projects within the interests of the students here
- students could work alone or collaboratively on any projects they chose
- we did not need unanimity about projects, but it was essential that if anyone opted for observing the group, we should have unanimous agreement about the processes involved.

Some of the students asked what sorts of things might be looked for in a group observation. The examples I gave included asking questions (including the 'Initiation Response Evaluation' pattern (Cazden, 1988), with illustrations from my own practice that evening) and teacher time spent on boys/men, an issue which had been raised by women students in end-of-term assessments discussed in the group. I asked the group to leave it for a couple of weeks to think about it. My notes that week include:

> *Joyce looked panicked. Priya looked genuinely excited, as I think did Andy, though he's more sphinx-like. .. I am wildly excited about it and find myself dreaming they all agree.*

The following week, I wrote

> *Raised question again of data collection and delayed to next week to think about it - I'm making myself leave time for students to be unrushed about it, though I may also be losing initial rush of enthusiasm from some of them.*

The delay did ensure that there was time for students to discuss the ideas amongst themselves. There was little further discussion in the class, but very prompt agreement, from the whole group, the following week; perhaps some students had discussed the idea amongst themselves meanwhile. They asked me to bring in samples of observation schedules.

3 The observation schedules

I knew from previous experience that collaborative work 'counted' for the unit, and assumed the group would nominate members to do the observing or write the observation schedule. I wanted a range of approaches so that the students' choices remained wide; I planned for the group to discuss together which type of schedule to use, and how to organise ourselves, with the possibility of the group writing their own schedule based on their own interests in what to look for. The following week I took in six sheets as examples (Appendix 5). Two were scaled response sheets (Cohen & Manion, 1989) I had been shown in research training (Boaler, 1991). I wrote four schedules: a timed observation sheet and three tally sheets relating to classroom talk: *Tutor's questions to students*, *Students' questions*, and *Who does the talking?*

My choice of categories depended on what seemed to me, from my experience of the group, both realistic and fairly easily recognisable. (It is all the more significant, then, that what the students saw surprised and worried me, as we shall see.) Gender issues had been raised in earlier course evaluation sheets, and I included questions on gendered patterns of classroom interaction. I didn't mention other possible categories which might be relevant, such as black/white, first/second language, age or prior educational experience. Since the group did not alter the observation schedules, what we looked for was determined by my suggestions, and therefore to some extent so was what we eventually saw in the classroom.

4 The observed classes

The following week, I took in a tape recorder, circulated all the observation schedules, and started reading/talking through them. The first was the 'teacher/student interaction' scaled-response sheet (Appendix 5). The talking through was necessary both because some of the students don't have all the technical reading skills necessary, and because I judged that some of the scales would not be immediately clear. As we read it, I noted some which would need re-interpretation for our own classroom. At a straightforward level, the group has *men and women*, not *boys and girls*. *Teacher sits at desk* is more complicated: there was no 'desk', since the tables were usually in a rectangle, and shifted for small group work; on the other hand, I usually sat at the same place, near the board (perhaps the equivalent of a teacher's desk).

Two of the scales were much more subtle and I am not convinced that the explanation I gave would match that of the researcher who wrote them. *Teacher asks questions which* *are answered by recall of: facts ... process* was clear to me, though I am not convinced I explained it adequately to students. *Teacher offers support to students by: structuring problem ... asking questions* was not clear to me, and I said so to the group.

Having gone through one sheet I realised that despite intending to leave decision-making to the students, I was in fact being directive and my voice was dominating the group. I said as much, and asked for a volunteer to take over the reading aloud. Joyce did so, reading the second scaled-rating sheet ('Students', Appendix 5), and then others read aloud the remaining sheets.

I stressed again that the group could use or amend any of the sheets, or make up their own. Theresa said

> *There's six. Split them up and do all of them.*

She was referring to there being six students. All immediately agreed, and that is what we did, though Trevor later opted against being an observer, and so I took the one sheet *(Who does the talking?)* which was left over. The upshot then was that five students and I spent the rest of the evening (about 90 minutes) observing each other. We also had the tape running.

Before discussing the observations in any detail, I will briefly outline the two classes that were observed: this one, and the following week's. The classes came towards the end of the unit and I wanted to check individuals' files.

The first week, I gave out individual work (including a nursery observation sheet for Carol to consider for her own project), and a worksheet involving reading a bar chart of a part-time worker's pay. Meanwhile I worked mainly with three individuals: Priya, Trevor, and Andy. For 15 minutes towards the end the whole group worked together (with me doing some calculations on the board) on reading a pictogram (required for the unit) with questions relating to calculations of percentages. Then as we wound up I read out the results of Andy's and Priya's work on the scaled-response sheets (opting to do the reading myself because I thought neither Andy nor Priya would want to read aloud on tape).

At the end of the evening, Andy borrowed the tape, the students kept their own observation sheets (and Theresa took mine), and someone suggested we repeat the exercise the following week; all agreed.

The following week, Joyce was absent. The group decided to change observation schedules so no-one did the same sheet twice. They worked on drawing pictograms, followed by about an hour on individual work; meanwhile I worked with two of the women on their files. All, including Trevor who had opted out the week before, took an observation schedule (as did I, replacing Joyce). I collected in the sheets to copy for the group. I didn't tape record the session, since the previous week's tape revealed the limitations of taping when much work is individual.

5 Collating the data

The third week, all six students were present. Theresa, Andy, Carol and Joyce worked on the data collected from the observations. As well as all the observation sheets from the two classes, they had a summary of the tape and a few pages of transcription. I chose a specific section to transcribe because everyone spoke and the tape was audible, and I told the group that it was not meant to be representative (indeed, since Priya spoke little, and Andy's voice was quiet, the transcribed section was atypical).

I had written a list of suggestions for dealing with the data (Appendix 5) and left the group to decide what to do. The four worked together, listening to some of the tape, and discussing what to do with the rest of the data. After 45 minutes Theresa announced *Carol will learn how to give the speech*, and Carol went through the group's findings. She explained they had decided to amalgamate the two weeks' observations. So for example the scaled-response schedules now had two ticks on most of the scales.

I could not take notes of all of Carol's report back because she went too fast. The substance was factual: she gave the number of ticks for each item, or summarised the findings (*Joyce didn't ask much,* for example). She mentioned that on the scaled-response sheets there were 'splits of opinion'. Aside from general murmurs of recognition and amusement, there was only one notable comment as the group listened to Carol's report. When Carol reported the number of questions I asked the men, Trevor said

Very strange research!

He said this as a half joke, but I imagine he meant it too. The gender imbalance was one of the surprises (to me, at least, and I suspect also the men, but perhaps not to the women students) and as the focus of the comments he probably felt pushed into making some response.

6 Sharing results

I did a summary of the tally sheets for the group the following (fourth) week, combining the results for the two weeks, as Carol had done:

Who asks the questions?

	Questions to the whole group	**Questions to women**	**Questions to men**
Tutor's questions to students Genuine question - wanting to know the answer	1	8	6
A question to find out if the student knows something.		2	11
A question to help the student work something out.		3	6
Other sorts of questions	3		3
Totals	4	13	26

Students' question	Carol	Andy	Theresa	Trevor	Priya	Joyce
Students' questions to the tutor Checking what the tutor wants them to work on, or checking what the task is.	1		1	1	1	1
Stuck and wanting help.	1	1		1		
Wanting factual information - for example, checking whether an answer is right.			1			
Students' questions to each other Checking what the tutor wants them to work on, or checking what the task is.	1	1	3	1		
Wanting factual information - for example, checking whether an answer is right.						
Stuck and wanting help.				1		
Other sorts of questions ..		1	1			
Totals	3	3	6	4	1	1

Who does the talking?

Names →	Andy	Alison	Priya	Trevor	Theresa	Carol	Joyce
Talking to whole class		3		1	1	1	
Talking in a small group or a pair	6			2	9	11	7
(Students) Talking to the tutor	4	6	6	6	2		1
TOTALS	10	9	6	9	12	12	8

I hoped it would be a more or less accurate record of Carol's report to the group. I circulated copies of the amalgamated scaled-response sheets (Appendix 5; the double ticking is because the group had combined the two observations together). We had more discussion of the data, particularly the scaled-response sheets.

7 What did we learn?

Here I discuss the group's comments on the data relating to gender and other discursive positionings in the class.

7.1 Gender

The first comment on gender was made by a man watching my work all one evening; the second comes from observations by two women over the two classes. Andy's rating-scale sheet recorded that I treated men and women differently. I exclaimed that I thought that was awful, and that men and women should be treated the same. All agreed with me, but Joyce pointed out that I had spent a long time with Trevor (who said nothing but seemed to agree). Carol said that was true, but added that she, Joyce and Theresa had been talking to each other, implying that they hadn't needed me.

Students commented too that I had asked twice as many questions of the two men as of the four women. Here I give my own gloss on this finding. In the first observed class I went through some individuals' files with them; the time I spent with Trevor is, I think, what led to the imbalance. In my notes of the first class (written before I heard the students' comments) I wrote:

> *Talked to individuals and checked files. Managed to talk to Priya, Trevor (for ages - he's worried; no file organisation; missed lots of work; said he thought examiners wouldn't mind if I explained he had missed a lot of the course ...) and Andy.*

It was Trevor's shortage of completed work (and therefore potential failure) that led me to focus on him, so I could argue that I was focusing not on 'a man' but someone with particular 'needs' in the course. An opposing case could be made that here we have a man treating the course casually and a gullible woman sorting out the mess for him, at other women's expense. Though neither of these positions was explicitly stated in the ensuing discussion, we did discuss the gendered 'air time' in the class, and my lack of explanation to the students of why a particular lesson was organised in a particular way.

There is no need here to come to a conclusion about this particular gendered relationship. What is important is that both gender politics and lesson planning issues were shifted from an informal, hidden arena into the formal curriculum.

I later had some insight into the effect of this discursive shift. A few weeks after the observation work was completed I asked Trevor to join another student for a particular piece of work. He said he didn't want to move; I said it would help me organise my time more effectively; he said I could see both students separately. It dawned on me that already, before we reached the maths work, I was spending a disproportionate time on him; my own view of my relationship with Trevor had been changed by the group's research. I decided to raise this but Carol got there before me:

> *Trevor! Consider your teacher! Remember what we said before!*

Everyone laughed, and Trevor moved.

7.2 Discursive positionings in the class

The observations led to a heightened awareness of differences in our understanding of what 'good teaching' or a 'good class' may be.

- The students agreed with the statement *Students wait for the teacher before moving on to new areas* ('Students' scaled-response sheet, Appendix 5). I know it's true (in terms of areas of maths, not necessarily in terms of particular algorithms or methods), but it saddens me. I would want people to explore maths more for themselves. Discussion in the group however revealed that for the students this statement is evidence that the group works well: they keep together; they are responsive to the tutor; they are disciplined; they respect their tutor.

- The group also recorded that they understand the teacher. I commented that it could not always be so. In the discussion that followed the students said if they do not understand, they assume it is their fault. Their point was that having decided that a teacher was good, they assumed difficulties in understanding arose from their own limitations.

- As I read aloud Andy's record that *Teacher is a dominant figure* (teacher/student interaction scaled-response sheet), I exclaimed *Oh god, no, am I?* Andy said it was not a criticism, and later I overheard him discussing it with other students, who supported his view but also clearly thought it was a positive comment. They also recorded my attitude as liberal (as opposed to authoritarian). To me liberal and dominant seemed contradictory; to the students they were entirely consistent.

- There were many comments in the group discussion about students' discursive patterns in the class. When someone commented on Priya not talking much, she told us she had (as a child) difficulties in adapting to life in Britain and using a new language. This was new information to me (she sounds like a Londoner); I, and perhaps others, had thought of her as a regular attender but not closely engaged with the course. Carol, Joyce and Theresa commented on enjoying working together (brought out by their high scores for *Talking in a small group or a pair).* Andy told the group he was very quiet on the tape, and added it was because he has a hearing loss (which may explain my view of him, prior to this discussion, as 'sphinx-like').

- I expected students to notice the tutor's use of questions in teaching. What they noticed in the schedules was the gender imbalance; the transcript showed questions more clearly (question marks stand out), and they commented on my use of questions as directions. For several weeks they laughed at me, on these lines:

  Alison *Shall we have a tea-break now?*
  Students *You mean you're having a tea break.*

  Alison *Shall we look at page 3?*
  Students *What happens if we say no?*

8 Research practices and discursive shifts

Here I discuss what 'counts' as research, and consider the impact of sharing research practices in the group.

8.1 Watching the detectives: what counts as research?

This was a participant observation exercise with several differences:

- everyone was both observed and an observer
- when we started, only one person had any experience or training (by the second week, we all had at least some experience)
- In contrast to most observation exercises, it was impossible to forget you were being observed, but observers did sometimes forget to observe *(Alison! Priya said something! Write it down!)*
- each observer had a different focus
- each focus was used twice, by different observers
- observed as well as observers had authority in the processes.

This research is not in any way 'objective', or even factual. For example, in the distractions of teaching at the same time as acting as an observer, I often failed to make a tally mark when someone spoke. When people were in pairs or small groups they often escaped the observer's eye. The tutor was observed six times talking to herself.

The limitations of our methods of observation were revealed during the two classes. It was clear (from the transcript as well as our own perceptions) that we missed a lot in the schedules which noted speech and questions; the meanings of categories on the scaled-response schedules were unclear, and relied on the observer's interpretations (of both the schedules and classroom discourse); much of the tape was indistinct, and quiet speakers disappeared. These limitations are not due only to our unusual uses of the research tools. Any observation is partly determined by what we look for (Hammersley, 1992) - in this case, gender issues, for example.

None of the students, as far as I know, has written anything based on the data we collected. Nevertheless, the four involved in collating the data had a detailed discussion about the observations and the whole group discussed the findings, so though there was no written record, both the processes and the findings of the research have gone into the collective experience of this group. All six have been involved in the discussions noted above. Some issues which were always there (like gender) were brought into the open; some issues (such as types of questions) were raised for the first time.

What I am writing now will 'count' as research. Does the students' work, not 'written up' other than here, count? It is clearly subjective, but so is any observation. In terms of triangulation, we could say this project has none (since there is no outside point, beyond the object of study) or too much (seven observers). The question of what counts as knowledge has been raised by the participants; it is a question for all those who took part, not only for the formally recognised researcher. I imagine it was the changed view of research with pre-set questions that led the students to challenge information I later took in from a newspaper report of a government survey into attitudes to crime. The students (in a session where their 'task' was to read pie charts) challenged the basis of the data, asking whether the questionnaire was multiple choice or open response; they were critical of *The Guardian* for not making it clear. So I would argue that doing the research generated two important shifts: a critical view of some research methods and their impact on data; and greater awareness of the discursive context in their own classroom.

8.2 Dissolving the distinctions between tutor and students?

Action research in AE has been claimed to

> *[Dissolve] the conventional distinctions between teacher and taught, researcher and researched. (Usher & Bryant, 1989:118-9)*

This seems naive. At the simplest level, the group observation undertaken by this group of students could not have taken place without my permission (and most likely would not have happened without my suggestion and framing).

The group observation did however suggest some approaches to a genuine sharing of experience, even though that cannot 'dissolve' conventional distinctions. Within a Freirean tradition (Freire, 1972b) it is usually assumed that tutors should 'encourage' reflection amongst the students; the reflection is a part of praxis (Fasheh, 1991) and leads to conscientization (Chapter 2). The one-way direction of 'encouragement' suggests a position of strength for the tutor, from which s/he can support others. At the level of the basic education syllabus, that is what I am paid to do: to be strong in maths, and support others. Discussing sexism in a text, or tracking the history of the supposed masculinity of standard maths - that is, using the tutor role to introduce gender issues into the maths curriculum - leaves (usually) the tutor in the leading role, and, further, positioned as an authority on power relations as well as on maths.

This group observation work was shared in a way few teacher-student projects can be. I was no better (no more accurate, consistent or perceptive) at observing the group than the students. My findings have merged into the collected findings. More than that, the work has made me more aware of gender issues in the group (terrain on which I thought I had considerable experience) and so I have learned from the students.

This project involved planned group reflection: not only a 'reflective practitioner' (usually taken to mean the tutor) or students reflecting on 'their' experience, but the whole group overtly reflecting on its own dynamics. Though the tutor-student relationship remains defined by those roles, it was changed by the experience. Shared reflection within the group on its own practices changed our discursive practices.

9 Summary and themes

Here I summarise the themes to be taken forward to the final chapter: unsettling discourse, and 'real life' in the classroom.

9.1 Unsettling discourse

We have seen students actively engaged in analysing and critiquing the discourse of their own classroom. Unpacking classroom practices makes them strange, and awareness of patterns of interaction unsettles those patterns.

This work exposed differences in our perceptions of our classroom discourse (for example, spending time with a student in difficulty, for the tutor; spending time with a man, for the students). It also exposed the difficulties inherent in any classroom analysis of discourse, because participants have different positionings and therefore different views of their shared discursive space. I felt that to be described as 'dominant' exposed my practice as oppressive; the students saw no conflict between *dominant* and *liberal*. This shifted my earlier view that a 'dominant' tutor was ruled out as a 'radical' tutor; as the research progressed I came to consider the dominance inevitable (tutors have institutional authority, at least, and usually other forms of authority too). The question then is how that dominant position can be used to strengthen students' voices in the classroom. While the initial questions were mine, I argue that positioning students as active inquirers into their own and my discursive practices led to shifts in classroom discourse which support the overall theme of 'empowering' students and strengthening students' voices.

9.2 'Real life' in the classroom

This chapter points forward, too, to another theme, considered briefly here and explored further in later chapters. The 'collecting data' course element is often seen as one means to 'bridge' real life and the maths classroom, through bringing in data from outside the classroom. Here the 'real life' under scrutiny was that of the classroom - a real place, in which real power relations are played out. The thesis will explore the limitations and ambiguities of the division in maths education discourses between 'real' or 'everyday' life and the maths classroom.

We all enormously enjoyed the work and the evenings on which we collected and discussed the data were punctuated with laughter. I met Joyce on the tube. In public encounters I usually avoid talking about courses but Joyce launched into telling me that she had spent an evening telling her friend about the observation work. Students' comments on their class record sheets include:

> *It was very good.*
> *Lots to learn.*
> *I really enjoyed it.*

Chapter 6: Investigating the 100 grid

1 Introduction

Here, in the first of three chapters concerned with the detail of maths discourse in the classroom, I discuss classroom work on the 100 grid (the counting numbers from 1 to 100, laid out ten rows of ten numbers: Appendix 6). The students' work as investigators, into the discourse of maths and into a particular mathematical structure, unsettles traditional classroom discourse, in terms of both authority patterns and communicative practices.

An investigational, conjecturing stance, for both students and tutor, is central to the shift in authority patterns. The conditions for establishing this stance appear to include collaborative work, students asking their own questions, returning students' texts for whole group consideration and the exposure of authority patterns, and I shall argue, as I do throughout this thesis, that these are key factors in the process of strengthening students' voices.

Like the 'interview' between Paulette and Cindy (Chapter 4), the data comes from an early period in the research when I was primarily investigating writing and its relation to student voice, and it similarly challenged a unitary idea of what 'writing' means. Writing, reading and talking are inextricably intertwined and each adds to the other; further, the data shows a meshing of semiotic modes, with the use of diagrams, gesture, colour, and written and spoken language combined.

I also use the data to challenge the academic/real world and abstract/concrete oppositions in discussion of the 'appropriate' curriculum for adults.

> *[Mathematics] is more than just the ability to do sums. It is about understanding the significance of number within ... our society. It is not about getting the right answer in a sum but about understanding how operations on data can clarify or obscure reality. It is not about meaningless processes applied to made-up problems ... (Benn, 1997a: 81)*

The 100 grid is an apparently 'meaningless' mathematical structure, and the investigation is internal to maths; it has nothing to do with how maths is used in (wider than classroom) society. I want to associate Benn's position with Valerie Walkerdine's questions:

> *What is the relationship between the classic concrete/abstract distinction and the one between a life in which it is materially necessary to calculate for survival and a life in which calculation can become a relatively theoretical exercise? Might calculation as a theoretical exercise have become the basis of a form of reasoning among imperial powers which depended for the accumulation of their capital on the exploitation of the newly discovered colonies? Do theoretical concepts come with wealth and what, if so, does this mean for economic and psychological theories of development and underdevelopment? (Walkerdine, 1997: 203)*

I argue that apparently meaningless (Benn) and abstract (Walkerdine) maths does have meaning for these students in their particular discursive context; I return to this in section 5.

My memory of the classroom discussion of the 100 grid and the transcript give the overwhelming impression that the discussion was *hard*. We all struggled, and you the reader will struggle too, to understand each other. In the classroom we had shared texts and other 'visuals' (section 3.4), but the bulk of the data discussion here is based on the transcript, and without the visuals it is difficult to follow. Rather than taking you through it in chronological order I have split the analysis into themes, though there is considerable overlap.

I start with the classroom, including the question of why we 'did' an investigation. That is followed by discussion of modes of communication:

- reading aloud
- writing
- talking and the development of common terms
- 'visuals'.

I then discuss questions of authority (mathematical and organisational) in the classroom. Finally, I summarise the themes from this chapter to be taken forward to Chapter 11.

2 Classroom contexts

2.1 Why an investigation?

Broadly speaking investigations are seen (in school and teacher training curricula) as a way for students to 'mathematise', asking their own questions (usually by extending initial questions set by teachers) and looking for patterns. In much of the literature the distinctions between 'problem-solving' and 'investigating' are not clearly defined; often 'problems' have a more defined range of solutions or derive in some way from the 'real world', and 'investigations' are more open-ended and are derived more directly from comparatively abstract maths. Candia Morgan analyses different uses of 'investigation' in the discourses of government policy, examining bodies and textbooks aimed at teachers and pupils, but identifies three ideal characteristics of investigational work common to all three arenas:

> *It is 'real' mathematics, it is open, creative, and 'empowering' for pupils, and it should 'permeate' the curriculum. (Morgan, 1998: 72)*

In my own work on investigations, as both a student of maths and a tutor, I am influenced by reading Leone Burton (e.g. Burton 1984) and John Mason (e.g. Mason 1988). The investigation discussed in this chapter broadly fits Morgan's listing of characteristics, with an important exception: investigational work does not 'permeate' ABE maths curricula, and indeed I think the work discussed here is unusual.

Investigations are not commonly part of the ABE maths curriculum and are not included in the most widely used accreditation schemes. The draft adult basic skills curriculum typically suggests 'investigations' as a way to introduce rules and procedures; they are therefore entirely closed. The examples given are not 'investigations' in the terms used by Morgan, above. At Level 1, for example,

> *Adults should be taught to: multiply and divide whole numbers and decimals by 10, 100 ... Use calculator or spreadsheet investigations to multiply whole numbers by 10, by 100 starting with single digits, two digits, etc. Deduce 'rules' from the patterns ...(DfEE and Basic Skills Agency, 2000: 138)*

The work of the group discussed here was accredited through the Open College. Unusually, their Algebra unit includes 'number patterns' and 'an investigation' (following the model outlined by Morgan, rather than the more limited BSA model). The group was working on the Algebra unit, and I proposed the 100 grid investigation.

My reasons for the choice included:

- meeting the assessment criteria;
- I hoped that it would give opportunities for the use and/or development of skills such as specialising, simplifying and testing out ideas, as well as examining and describing patterns;
- this particular investigation is accessible at a range of levels and has a wide range of possible interest within it;
- it would lead students to practise addition and probably subtraction, with the possibility of other technical skills as well;
- the investigation is based on the counting numbers, a structure which the students knew well.

2.2 The classroom

The group of eight students met once a week, for two hours. Most of the work was done in the classroom, which is narrow and cramped. The tables were pushed together to give a four-person long, one-person wide central block, and we were packed. Once squeezed in you didn't want to move, and the students tended to sit next to people with whom they worked well, and share work with two or three people, rather than with the whole group.

2.3 Relevant prior experience

The students had *read* very little mathematics, as far as I know. (They all had limited schooling so their access even to the discourse of textbooks was restricted.) They had read each others' maths histories and reviews of course work, but they had not read any other students' writing of mathematics. Their experience of *hearing* 'expert' use of spoken mathematical language depended on me, and (as will become clear) I am not a model of clarity and precision. So they were setting off down an unknown road.

This was the group's first work on an investigation, and it came in the third term when the group had met regularly for two terms. We worked on the 100 grid for one hour of each of the previous two lessons; two students (Dave and Yvonne) also worked on it at home, and one (Frank) tried to but didn't think he had got far. We agreed to copy and share some of the work, and discuss it in the group; I taped the discussion. Seven students were present. We read and discussed four students' work, and referred to others' during the class.

2.4 Telling stories

Leone Burton, citing Freire on the political power of literacy and thus invoking discourses of empowerment, argues that a narrative approach supports the development of coherence in mathematics and empowerment of learners:

> *Narrative ... is an attempt to impose coherent meaning on experience. Connectedness, and consequently coherence, is a necessary part of narrative ... Narrating is* a, *possibly* the, *way to explore the meaning of experience. Narrating is participatory, involving a community in telling and responding to a story... It is the pedagogy which is powerful in either mystifying or making clear the mathematics, disempowering or empowering the learners ... I claim that a narrative approach to mathematics and its pedagogy is consistent with a view of mathematics as being socially derived and with the understanding of mathematics as being socially negotiable. The former is the content, the latter is its pedagogy. (Burton, 1996: 30-33).*

I had done some work with the group using some of the words promoted by Open University texts for new adult maths students (Mason, 1988), and put some prompts on the initial sheet: 'Stuck! Aha! My mistake was ...' These are consistent with Burton's 'narrative' approach in that they invite the student to tell the story of the investigation rather than only give 'findings'. However, none of the students used any of these terms. They didn't write about the history of their work on the 100 grid (though as we shall see some transformed their writing as they spoke into an oral narrative form), but about the content.

Burton argues narratives may be told, written, drawn or acted; those four modes were all used in this class. As we shall see, the class illustrates the complexity of participatory story telling in a maths class and the productivity of the struggle to achieve 'coherent meaning'.

3 Writing? talking? reading? listening? waving? Modes of

communication in the class

In the initial work on the investigation, the reading aloud and subsequent work we see a mix of communicative modes.

The overarching impression from all this is that the discussion was hard. The effort was to understand both each other and the 100 grid; indeed, that distinction itself, between representation and concept, may not be useful. These difficulties in communication led to the range of communicative modes in play in the class. I have organised this section in terms of four categories - reading aloud, writing, talking and 'visuals' - for the sake of clarity in analysis; but as I shall show, all were mixed in the classroom.

3.1 Reading aloud

The discussion was broadly organised in four sections, around work by Dave, Frank, Yvonne and Violet. Each student's reading of her/his own writing was accompanied by discussion. I first consider what was involved in the process of reading aloud: self correcting, expanding, and criticism, from both the author and others in the group.

I had two main purposes in asking the students to read aloud what they had written. One was to help weaker readers with the difficulties of reading handwriting; the other was to establish shared material as a basis for discussion. However, the students did not simply 'read' what was on the page. They created new texts in the process of reading; in effect they re-wrote texts through speech. I will illustrate this with Dave's, Yvonne's and Violet's reading aloud (Frank's is discussed in section 3.2.2). *Times New Roman (italics)* typeface is used to show words quoted from a written text. Numbers in brackets indicate pauses of one second or longer.

3.1.1 Dave

Dave started off deciding not to read out some of his piece:

> Right, I'm missing the top bit where it says *The grids are squared*, obviously they are, like Alison said.

I asked him to read all of it:

> *Alright (.) The grids are squared, obviously, and in the 4 number window if you add criss cross you get the same answer. If you add across straight the answer goes up in 20. If you add down, the answers are 2 apart, and also the numbers going down go up in tens. It doesn't matter where the 4 windows are, they have the similar patterns, they have similar patterns as above. If you change the shape of the window to a 9 number window, criss cross the answers are the same, across horizontally the answers go up in 30s, down straight, the answers go up in 3s. And on the 16 window, criss cross, answers are the same, across horizontally, answers go up in 40s, and down straight, answers go up in 4s.*

Even here he made some changes, though we may regard them as trivial. He changed 'the answers go up' in the writing to 'the answer goes up' in the reading. He amended the written short form 'ans' to 'answers' when speaking. He inserted the definite article *the* in 'they have the similar patterns', and then corrected it to 'they have similar patterns.' The main departure from the written text, however, is just that he stopped here, and summarised:

> So there's a pattern developing, like.

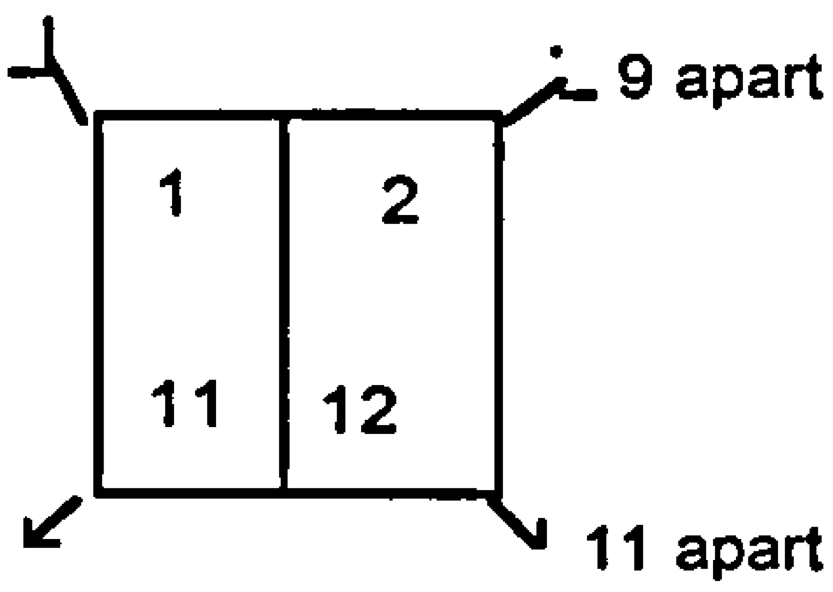
When invited to continue, he summarised part of the text (saying 'hang on a minute' while he found his place), focusing on what he had identified as 'adding across straight', and ignoring the 'criss-cross' and 'down' sums:

> you got, e:r, in the 4 number windows, the answers go up in 20, and er (1) hang on a minute (4) in the 9 number window, the answers go up in 30, in the 16 number windows, it goes up in 40. (2) And so on, you know?

At this point I asked the group to consider what 'and so on' meant (section 4.1). Dave's two further points were never read out or discussed. The first was

> 7 x 7 grid. Ans go up in 14. Ans 2 apart

The second was two diagrams illustrating differences of 9 and 11.



This idea wasn't raised until later (when reading Violet's), when Dave came back to it without overt reference to his text.

Something else was missed out too. When Dave started reading, he'd said,

> Right, I'm missing the top bit where it says The grids are squared, obviously they are, like Alison said.

I interpreted Dave's 'pattern' in terms of square numbers: I saw his '4 number' and '9 number' windows as 2^2 or 3^2. On re-reading his text I see that he had written

> The grids are squared, 10^2

Because he didn't read out '10^2', his evident grip on the idea of square numbers escaped me. Similarly he had a comment at the bottom of the sheet, again not read out, which showed a list of square numbers:

> In all the 4 window 9, 16, 25, 36 to the 100 window

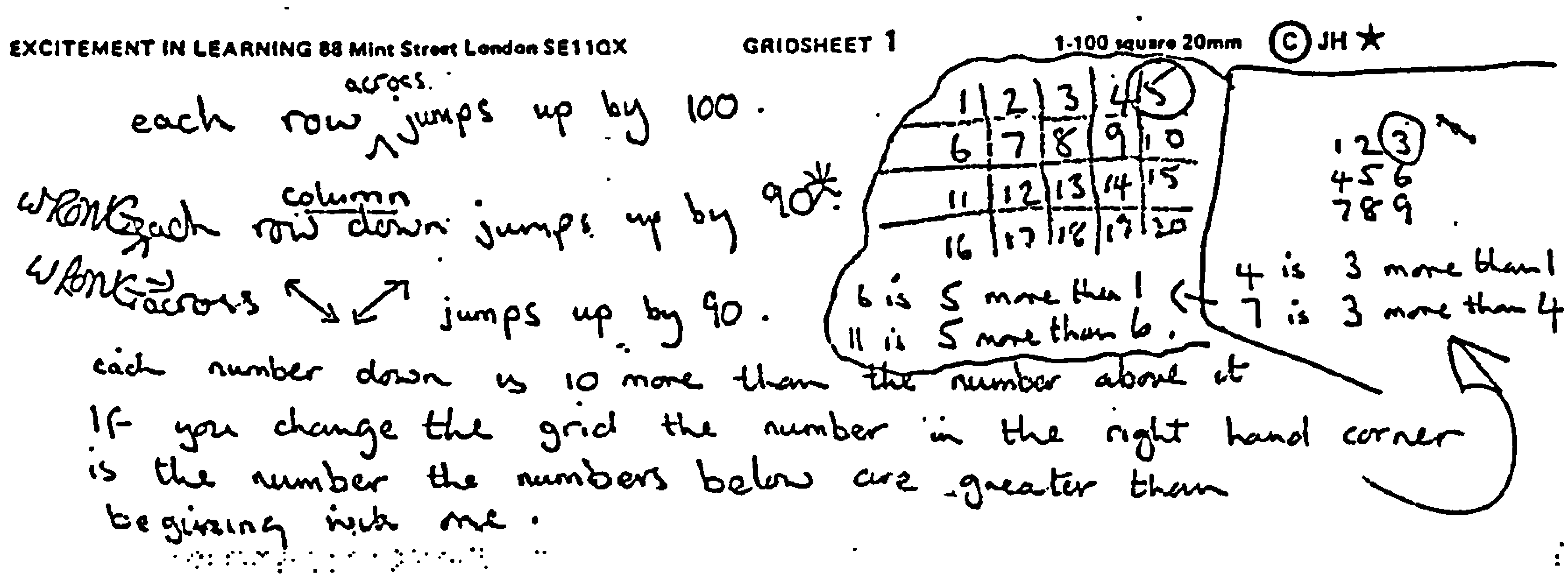
The list might have been useful to the discussion and was never examined. The group discussion was partly determined by what was read aloud, as distinct from what was written.

3.1.2 Yvonne

Yvonne's 'reading aloud' similarly included her gloss on the text:

> Each row (.) or column jumps up by 90. *I do think that works out wrong. Um, and* across *ways I've said it goes* up by 90, *but that doesn't either.* Each number down is 10 more than the number above it. *And then, I looked at (1) how the grid would change if you didn't have a 10 grid, you had a (.) like a 5 grid or a (.) 3 across. And* the number in the right hand corner (.) is (.) *I've written* If you change the grid (.) the number in the right hand corner is the number that the numbers below it *[chuckles]* are greater than. *See (.) if you look at the 3 grid ..*

The effect of the insertions is to move the text to a more personal narrative. This is what she wrote:


EXCITEMENT IN LEARNING 88 Mint Street London SE1 1QX GRIDSHEET 1 1-100 square 20mm © JH ★

each row across jumps up by 100.

WRONG each ~~row down~~ column jumps up by 90

WRONG across jumps up by 90.

each number down is 10 more than the number above it

If you change the grid the number in the right hand corner is the number the numbers below are greater than

beginning with me.

1	2	3	4	5
6	7	8	9	10
11	12	13	14	15
16	17	18	19	20

6 is 5 more than 1

11 is 5 more than 6.

1 2 3

4 5 6

7 8 9

4 is 3 more than 1

7 is 3 more than 4

The only personal pronoun is the indefinite 'you'. The verbs are active but the agents are numbers, rows and columns.

These are Yvonne's insertions:

> I do think that works out wrong....
>
> I've said it goes ...
>
> And then, I looked at (.) how the grid would change if you didn't have a 10 grid, you had a (.) like a 5 grid or a (.) 3 across.
>
> I've written ...
>
> See (.) if you look at the 3 grid ...

These in-the-reading additions have the effect of turning the text into a personal narrative in which Yvonne is the agent and speaks directly to the reader/hearer. She made her narrative personal, by presenting herself as the agent, only in the reading aloud. I would argue a live audience rather than a silent imagined readership supported such a switch; in Burton's terms, her representation of maths is 'socially negotiated' ('See, if you look at ...').

One aspect of Yvonne's writing cannot be directly 'read aloud'. Her third main written statement (the second she had marked WRONG) involved the use of two arrows. She used the word 'across', and presumably put in the arrows because 'across' is ambiguous (she had already used 'across' in the first line, with a different meaning). Later in the discussion I checked the meaning of the arrows:

> *Across diagonal (.)* Those little arrows mean diagonal, does it? *Across diagonal jumps up by 90.*

The group spent some time examining Yvonne's proposition (section 4.2). It may be that the fact that the arrows were not 'read out', and were first 'read' as 'across', led to a miscue.

3.1.3 Violet

Violet's work is copied on the following page:

Number grid investigation

1	2	3	4	5	6	7	8	9	10
11	12	13	14	15	16	17	18	19	20
21	22	23	24	25	26	27	28	29	30
31	32	33	34	35	36	37	38	39	40
41	42	43	44	45	46	47	48	49	50
51	52	53	54	55	56	57	58	59	60
61	62	63	64	65	66	67	68	69	70
71	72	73	74	75	76	77	78	79	80
81	82	83	84	85	86	87	88	89	90
91	92	93	94	95	96	97	98	99	100

3
26
73
30

Take 1st grid - of
1×2 = 2
11×2 = 22
12×2 = 24

there fore you may find is eith two less or two more or 20 or 22 more. in × sign.

When added in a shape of triangle in the last grid e.g. 88 89 99 = either one less or one more even 10 less.

89 + 99 = 188   88 + 99 = 187   88 + 89 = 177

can be done in take away as well 67 − 66 = 1. 77 − 67 = 10

What happens when you add the numbers in the windows?
Can you find any patterns? Yes
Does it matter where the window is? No
What happens if you change the shape of the window?

Add up diagonally. I got the same answer.
e.g. 52+63=115
62+53=115

Investigate ...

18
19
37
46
54

Extensions:
What happens if the grid is not 10 x 10, but 7x7, or 4x4?
Try other grids.

In some grid you may find 2 less or 2 more.

also it can be divided by a number to give you different figure, but you may find out that that can be reduced by

84 + 94 = 178   85 + 95 = 180
2 | 178 = 89   2 | 180 = 90
– increase or decrease.

Some useful words for your notes:		
Stuck!	Aha!	My mistake was ...
Then I tried ...		I wonder if ...
It doesn't work because ...		It works because ...
I don't know why ...		

Violet's 'reading aloud' of her text was full of interruptions and digressions by other speakers, including me.

This is the opening section, with additional comments in the right hand column. Her example is the top left corner of the grid:

Violet	I hope I understand it myself. It says *Take (.) take first grid of* so I work it out, which is *1 times 2, equals 2.*	*Reads from text.*
Alison	Uh huh	
Violet	*11 times 2 equals 22.* I have got three column (.) three examples here. And *12 times 2 is 24.* So *therefore you may find is either two less or two more or 20 or 22 more (2) in* equal sign. (.) That means, times sign.	*Violet's use of 'examples' suggests a general pattern, rather than a one-off finding. Corrects herself: the sign she has given in writing is x*
Alison	: Right.	
Violet	So if you times it. So, the first one I got 2, the second one is 22. So I have got 20 more.	*Gives an example not included in her writing, to illustrate her meaning.*
Alison	11 times 2, and 12 x 2. Ok.	*Checking on the grid*
Dave	But isn't it add?	*Challenging basis of Violet's work; start of a five-turn digression*
Alison	Well, Violet's doing something different.	
Dave	It's just like the question (.)	
Alison	Nobody said you're not allowed to multiply.	

After Dave's question on the 'rules' of the investigation, Violet summarised what she had done, and was about to move on. Like Yvonne, she turned the maths into a personal narrative:

> So I used all these four numbers in the (.) column (.) is it? is that the word to use? In the grid, in the grid, in one grid, and then

I was worried that I had not understood her point, and tried to check.

Alison	Mmm hmm. You've not done quite all the numbers, but (.) were you thinking you'd multiplied every number by every number?	
Violet	Yes, so that's what I did.	
Alison	Because you haven't done 11 times 12.	*Negative response.*
Violet	No:, no: I haven't done that.	
Dave	Which is a (.)	
Alison	And 11 times (.) [1	
Violet	[I did 11 times 2.	
Alison	You've done the two crossways one, you've done 11 x 2	*Unclear:* two *crossways* one?
Violet	Yes, and I haven't done 12 times 1, and all that. So [I was thinking	
Alison	[Still it's interesting, isn't it?	*Interrupting - probably realising I had been negative and trying to recover*

Violet	Yes, I was thinking whatever is added is either going to be 20 or 22 more.
Alison	Ok
Violet	Ok, we come back to that, it's a good idea =
Alison	= Yeah, yeah.

In this exchange I had a negative effect on the development of a mathematical idea. Violet's original statement was 'I used all these four numbers' (i.e. 1, 2, 11 and 12), and indeed she had. I initially said she hadn't 'done' all four numbers, and corrected it to 'multiply'. She was I think developing an idea of relationship between the products of numbers in a 'window' expressed in terms of their differences. There was no further discussion of this idea.

Violet returned to her text:

> And *when added in a shape of triangle, in the last grid,* which is, I've got 88, and 89, and then 90

She was misreading here, and someone corrected the 90 to 99. There were two key themes in the next exchanges: tens, and elevens. I will start with the *tens.*

Violet translated her three written addition sums into words:

> So I don't know whether it was [inaudible] but I took those three numbers, in the last grid, *for example like 88 plus 89 plus 99, either one less or one more, even 10 less.*

She said 'even 10 less' in a deliberate tone indicating surprise - she drew our attention to the special nature of the number 10.

> So I added *89 plus 99* and I got *188.* And I got 88, plus 99, I got *187.* And I added 88 plus 89, in the other way, across, I got 177.

Dave said,

> Oh, it's 10 less than that

(i.e., presumably, 177 is 10 less than 187) recognising why Violet had stressed 10. Violet continued:

> Yes, 10 less. So (.) and I said that it *can be done, in take away as well.* So I have given an example of *67 take away 66.* And I have got *1* left. And I did give another example. *77 take away 67*, and I got, 10. So 10 is bigger than 1. But (.) before you add up, you take away, you can see that you've only got 2 gaps.

This is a re-wording of the written text's *gap of* 2. This reading of Violet's text led to a further digression when I introduced the idea of inverse:

> That little bit (.) I think is what you'd call the inverse of what other people have been talking about. Like, people have been saying (.) the next number along the row as you move to the right (.) you add 1. It's the same as saying you were saying if you move to the left you take away 1. ....As you go <u>down</u>wards ... the numbers increase by 10. And you worked that out by subtraction. (.) So it's the same thing, isn't it, but expressed a different way.

In the face of my taking over the space, Violet temporarily gave up on her attempt to read out her text, and responded to me only with 'Mm hmm, yeah'.

I will now look at the *elevens*. As Violet gave up, Dave introduced an apparently new topic:

> There's something that we all haven't mentioned. The fact that ... Um, in this grid here, well, in all the grid really, there, 11 apart, you go across that way and those (.) are (.) 9 apart. And that's the same pattern all the way through.

As he spoke he pointed to the 66/67/76/77 'window', indicating that 66 and 77 are 11 apart, and 67 and 76 are 9 apart. Dave thought no-one had mentioned this so far (he noted it on his worksheet, but had stopped reading before he reached it). However, Frank had tried to introduce the idea during Violet's exposition of the work she had done on a triangular window (quoted above). He talked through Violet's reading, saying quietly:

> The top two is one more, and the bottom one is ten more ... No that should be 11 though ... 11 more. It goes one (.) 11 more.

Frank has said and written that he finds working in a noisy argumentative group very difficult. His concentration goes, and he finds it hard to think. He is not confident and seeks tutor 'marking' constantly. Here he seemed to be entirely focused on the maths and creating a thread of thought coherently and successfully. It is possible that having students' work, clearly flawed, in front of the group, and having the tutor's voice less dominant than usual and also clearly flawed helped him relax.

3.1.4 'Reading aloud': summary

We have seen here that 'reading aloud' is not a unitary, simple mode. Writers' in-the-text amendments changed the written text, so in one sense they were *writing* as they read aloud. The meanings of the texts were further changed by others' interventions. Written texts are sometimes described as a permanent record of language (this view is critically addressed by many writers; see for example Barton, 1994; Gee, 1996). Here there was little 'permanence', in that the border line between spoken and written texts is hard to decipher. Aside from clear changes discussed above, some may be hidden in my own transcription. For example, Violet wrote in numerals and other symbols:

$$\begin{array}{r} 89 \\ \underline{+99} \\ 188 \end{array}$$

I transcribed what she said like this:

> So I added *89 plus 99* and I got *188*.

I decided to keep the use of numerals (*89* rather than *eighty-nine*). I decided that *I got* was not in the written text, but perhaps the horizontal line means 'I got'. I treated Violet's word *plus* as a reading of the + sign (transcribed in *Times italics*), but many people read + as *add* or *and*. So the process of deciding what was written or spoken text is not straightforward, and I would argue the evidence here is that a written text is not a fixed or exact record of a writer's intentions for its reading.

On the other hand, there is some sense in which its 'outside' quality is important. It can be argued over and challenged; it doesn't disappear, so for example Dave was able to refer back to his writing to raise his argument about elevens, and Frank seems to have been able to focus on a written text to help him concentrate on pursuing a mathematical idea.

3.2 Writing

I expected the students to have difficulties with the technical requirements of spelling. No-one mentioned it directly, though we must beware that spelling difficulties may have restricted what students wrote. We did have some discussion about the difficulties of expressing in writing mathematical ideas; that is, analysis of their own language use in different discursive contexts. The students found that what they had written was not an adequate record of their ideas; hence they sometimes could not remember, on re-reading, the meaning of their own writing. What was expressed in writing was neither the whole nor a summary of their mathematical thinking on the topic. As a means of assessing their understanding, therefore, it seems inadequate (and the tape transcript was used in evidence for accreditation of their work).

I will look at two episodes from the discussion which illustrate these issues.

3.2.1 'I seem to have done it in sums'

The first episode arose from Dave's reading out. In checking whether the group understood his ideas, I said

> I think I lost him here and there

and Dave replied,

> Yeah, I've lost myself a little bit, actually, um, because I didn't write it down properly.

After further discussion, Dave came back to the issue:

> I haven't written enough information. I seem to have done it in sums.

So 'sums' and 'writing information' are different. Dave's worry was that he couldn't adequately recall, and express to the group during the discussion, some of the mathematical thinking that developed from the work on 'sums'. We then had this exchange:

Alison	Dave just said he hasn't written enough information. What do you think? Do you think he has? I mean I think this is a very good stab at (.) something that's very hard.
Violet	I think he has, but (.) it's just difficult to ... Maybe, at the time he was doing it, he was sure what he was doing, and now that he is going over it, for somebody to explain, I think it's a bit um =
Dave	= My English writing isn't very good, that's my problem.
Alison	See I almost think that you're trying not to do English writing, that's the thing, you're trying to do maths [writing

Violet	yeah, yeah
Alison	Do you know? and maths is worse than English.
Dave	But I [just can't seem to put
Violet	[I think you have to (.) use the right word for (.) maths (.) like increase or decrease. I mean you sort of know what word to use and then fit it in properly, and writing it =
Alison	= It's not one answer. I would find this <u>extremely</u> hard to do.
Violet	It is.
Alison	You haven't seen me doing it, have you, because it's very hard to do.
Dave	I can explain the 100 grid better, because I've written that out in (.) .. numbers. [This refers to the Dave's second sheet, '100 number window']
Violet	Yeah, it's difficult, it's difficult to explain.

Violet's suggestion that at the time Dave did the work he was 'sure what he was doing', implying that the writing does not adequately record his ideas, became a theme of the discussion, cropping up in connection with others' writing. When Dave started to explain his second sheet, Violet laughed:

> *Even you remember what you did?*

Dave answered,

> I don't know how I did it.

When Alev embarked on explaining part of her work, she said,

> Then I divided it by 117 I think. Where did I get the 117 though?

When Dave uses the expression 'English writing', he usually means spelling. When I distinguished between English writing and maths writing, the impulse came from my feeling that spelling was *not* the problem. It seemed to me that in talking, as well as writing, we were (all) having difficulty expressing mathematical ideas. Violet then defined maths writing as using

> the right word for maths, like increase or decrease... you sort of know what word to use and then fit it in properly, and writing it.

This involves several assumptions. One is that there is a vocabulary specific to the genre, and indeed mathematicians do write 'increase' rather than the 'go up' or 'jump up' used here. Another is that the words are all arranged before writing; the writing is the record rather than process of composition ('writing it' seems here to mean 'writing it down' (moving the pen), rather than composing). It seems also that 'knowing what word to use' and 'fitting it in properly' may *constitute* mathematical thinking.

I was concerned that Violet thought there was a model answer, hence my denial: 'It's not one answer'. My second comment seems, on re-reading, very odd; perhaps I was embarrassed at my own difficulties in talking about the mathematical patterns. 'You haven't seen me doing it' relates only to this particular problem. I had 'modelled' writing mathematical notes with the group, and from that had given them a prompt list on the worksheet identified as 'useful words', though for this particular piece of writing the framing I had offered was presumably use*less*; at any rate, it was not used ('writing frames' are also discussed in Chapters 4 & 10).

3.2.2 'Is that what we meant?'

The week before the group discussion Frank did some writing about the investigation. The work in his handwriting was entirely his; the final sentence in my handwriting was his wording, but produced in discussion with me (I seized upon it and said 'we' should write it down); and the correction of 'line' to 'column' was mine, made after I inquired into the direction of the 'lines' Frank was writing about.

I invited Frank to read it out:

Each sum is different one after the other. Starting from the Lowest number and adding up to the highest numbers. When you add them in a ~~Straigh~~ Straight. column line each column line ~~...~~ add up differently. Because each row adds up by ten ~~two~~ 0. To give the answer.
They are 2 apart, because each column is one more than the column before.

> Yeah. Start here. *Each sum is different one after the other. Starting from the lowest number and adding up to the highest numbers. When you add them in a straight line each -*

He paused, unable to decipher the next word. I said 'Line, I think' - suggesting 'line' because he had already ignored my change to 'column'. He continued reading:

> *each line adds up differently, because each row adds up by ten to give the answer* (154)

stopping at the end of his handwriting. I suggested we needed to look at his sums, and asked

> So *each sum is different one after the other.* What (.) just tell us what you're saying there Frank? What does that mean?

He said,

> I think each of them adds up by 2.

I take it he was referring to the difference of 2 between 172 and 174, and 178 and 180. I told the group that I had changed 'line' to 'column', and that column means 'going up and down'. I then read again the last sentence written by Frank:

Alison	Which means the word for that is a column. (4) *Each* (.) What's that word? *Each*
Frank	*Each row*
Dave	Each line, isn't it?
Frank	*Each row* Sorry
Alison	*Each row*
Frank	*adds up by ten*
Alison	*to give the answer.* What does that mean, each row adds up by 10?
Frank	(9) Um, I don't know.
Alison	[to herself] *Each row adds up by ten.* [to Frank] Each row below is ten more than the one above?
Frank	Yeah, yeah.
Alison	It could be.
Frank	It could be.

Just above the word 'row' in Frank's writing is a tick, a record of my agreement with his use of the word during the discussion when I amended 'line' to 'column'. I had understood Frank's meaning, but I could not confidently find it one week later.

I went on:

> And then the bottom, that's my handwriting at the bottom, but it's what Frank said, was *They are 2 apart, because each column is one more than the column before.* Which at the time when we wrote it looked crystal clear [laughs] but now I don't know what we were saying. (4 secs. pause)

Dave gave a possible explanation, to his teacher, of what his teacher had scribed and couldn't understand:

Dave	But that's horizontally, isn't it. If you look at 52 and 53, that's <u>one</u> apart from each other. If you look at 62 and 63 that's one apart from each other. But if you add <u>down</u>, right, they're 2 apart from each other. (3)
Alison	I probably agree. Run that past me again? What? [laughs]
Dave	I'll show you, I'll show it, because it's easier to show it.

[Dave moved next to me and Frank and pointed to the grid as he talked.]

Alison	Right.
Dave	Look, you've got 52 and 53, and they're one apart, aren't they?
Alison	Yeah
Dave	And 62 and 63 is one apart but when you add down
Frank	They're 2 apart =
Dave	= They're 2 apart.
Alison	[Ok, I've got that
Violet	Yeah, yeah
Alison	Is that what we meant, Frank? (.) I think that probably is what we meant, that makes sense.
Frank	I said <u>two</u> down there, didn't I, and I rubbed it out.

This debate continued for a few minutes. I don't know whether any of us was confident in an interpretation by the end of the discussion of Frank's writing. What's clear is that every word was struggled over; the struggle was in the written text ('I rubbed it out') and in the spoken text; authorship is plural (Dave's gloss has a powerful effect on my reading of the text; I refer to 'we' as author). In his effort to explain to me and Frank, Dave squeezed round the cramped table so that he could point to numbers and trace directions.

I imagine our collective difficulties in understanding Frank's writing illustrate a reason for the development of 'writing maths' as a pedagogical strategy; there is an argument that if we are to do 'good' (easily understood) writing about the 100 grid, we need to understand its structures clearly, that these can best be expressed in the compact, specialised notation of standard mathematics, and that the process of writing itself can support the reflection that leads to understanding. For an extreme example of this position, see Henriksen (1992), who argues, 'Succinctly put, all you have to do is refuse to read work that is not explained and stand fast in the face of strong resistance' (claims for the benefits of writing in learning maths are discussed in Appendix 1).

Morgan argues, on the other hand, that 'standard' mathematics itself is not one discourse: for example, the discourse of a mathematics research paper is different from that of a primary school text-book (Morgan, 1998). This transcript illustrates the difficulty of knowing when and if a shared understanding is achieved (i.e. if the written maths is 'good'). There are indications that speakers believed knowledge was shared. For example, Dave said, 'If you look at 62 and 63 that's one apart from each other. But if you add down, right, they're 2 apart from each other'. The meaning of *they* here is assumed to be shared. *They* referred, I now think, to 134 and 136, respectively the sums of 62 and 72, and 63 and 73; at the time, I was not sure I understood (deixis (Hatch, 1996) is further discussed in section 4.4).

The draft Basic Skills Curriculum directs teachers to:

> *Encourage learners to use mathematical vocabulary, but make sure that they understand everyday language used in a mathematical context. (DfEE and Basic Skills Agency, 2000: 188)*

The evidence here suggests that the establishment of shared meanings is extraordinarily complex. It was beyond the ability of at least this tutor to 'make sure the learners understood'; I did not always understand myself.

3.3 Talking

Most of what I have quoted so far from the discussion has held the possibility of different interpretations. Most of the discussion - most conversational turns, and most time - was spent trying to understand each other's meanings. All involve metaphors; some are old and have become standardised ('the numbers go up', for example), and others were invented on the spot. First I highlight particular ambiguities centring on prepositions, spatial directions and numbers; then I consider expressions more overtly negotiated and agreed by the group.

3.3.1 Up and down

'Up' and 'down' gave us particular difficulty. This example comes from Dave, who himself half gave up as he read out his work:

Dave	Yeah, I've lost myself a little bit, actually, um, because I didn't write it down properly.
Frank	If you go downwards, they all go up by 10s.
Dave	Yeah
Frank	If you go the other way, it goes up by the next number, isn't it?
Alison	Yeah (.) So that bit about downwards (.)
Frank	It goes up in 10s.
Dave	All the numbers going down goes up in 10.
Alison	Yeah, you've got that at the end of your first paragraph, haven't you.
Dave	Yeah.
Alison	*The numbers going down go up in 10s.*

The difficulty is that the directions are both on the page, when 'up' means towards the top of the sheet, and in numbers, when 'up' means a bigger number; yet bigger numbers come lower on the page.

3.3.2 Numbers: 'these kind of thing'

Up and down, then were difficult; but stating what was moving up or down was equally so. This example comes from Yvonne, who in explaining where she had gone 'wrong', said,

> And then I decided by looking at the second number(.) the 9s, or the 8s, and then I decided that that couldn't or wouldn't be right, for some reason.

I tried to check what she meant:

> Say that again a bit, you started looking at the second number, like the units number, yeah?

Yvonne agreed, and then amplified what she had done:

> Yeah; and I think I started adding <u>them</u> ones together, instead of (2) looking how it jumps down by 10, every time. I started (.) crossing it over, and adding them all together, instead of (pause)

Dave summarised:

> So basically what you're saying is you was doing the answers rather than just actually sort of looking at the numbers before you did the sum. Is that what you mean?

Yvonne (after a pause) said she didn't know and was confused (as I was), and Dave sympathised with her. The problem here may have started with the use of 'numbers' for 'digits'. I tried to get clarity by introducing the word 'units', but no-one took me up on it. Dave's phrasing may suggest that 'doing the answers' and 'doing the sum' are the same thing, but it's unclear to me what that thing is.

We lacked an agreed way of categorising numbers. We didn't use the words which define the origin or potential function of a number, such as total, product, difference, factor or digit, and 'sum' meant any calculation. We had many 'answers' but often they were not attached to obvious questions or calculations. For example, Violet read from her text:

> It can be divided by a number to give you a different figure.

That indefinite article makes the number sound like *any* number. I asked for clarification, and this is what Violet said:

> It can be divided by a number, let's take for example 84 ... plus 94, you get one seventy-eight. And if you divide it by 2, take a number like 2, you divide it by 2, you get 89. And also I make another example, which is 85 plus 95, I got 180. And I divide it by 2, and I got 90. So between those two examples, there is only one (.) one number.

The 'one number' is the number *1*. The 'it' of 'it can be divided' is the sum of 84 and 94; 'a number' is 2, though it might be 'like 2'. Has Violet found the *averages* of two pairs of numbers to have a *difference* of 1? She may have divided by 2 in order to find an average (though as far as I know she had not worked on averages); she may have been looking for common factors and hit upon 2. In the absence of a more precise vocabulary, Joyce nevertheless tries to distinguish categories of numbers:

> then you going to add these kind of thing.

It would be easy to dismiss Violet's writing (and perhaps her thinking, if the one is taken as a representation of the other) as muddled:

<table>
<tr><td></td><td></td><td>Also it can be divided</td></tr>
<tr><td>84</td><td>85</td><td>by a number to give you</td></tr>
<tr><td><u>94</u></td><td><u>95</u></td><td>different figure, but you</td></tr>
<tr><td>178</td><td>180</td><td>may find out that that</td></tr>
<tr><td><u>89</u></td><td><u>90</u></td><td>can be</td></tr>
<tr><td>2|178</td><td>2|180</td><td>reduced by</td></tr>
<tr><td></td><td></td><td>1</td></tr>
<tr><td></td><td></td><td>increase or</td></tr>
<tr><td></td><td></td><td>decrease.</td></tr>
</table>

The discussion of Violet's work revealed that her mathematical thinking was far more complex than her writing by itself suggests.

3.3.3 Columns and rows

I introduced 'column' and 'row' as words that (I thought) were more precise than 'line'. Here is a sample of the group trying out the new usage. Yvonne's original text read 'Each row down jumps up by 90', but she corrected 'row down' to 'column'. In reading it out aloud, she hesitated:

> Er, each row (.) or column jumps up by 90.

After some debate, Dave decided that the idea was right, but the expression was wrong:

> I think you was wrong in explaining, the way you explained it. (..) Like that, you said, um, the row down jumps up by 90

I reminded him that Yvonne had changed it to 'column'. Dave said that would be wrong, and when I disagreed, asked,

> Oh, does the column mean the whole amount?

I was unclear what his question meant, and rephrased my definition of column:

> Column is top to bottom.

This contented Dave: 'Then that's right'. I don't know what 'the whole amount' meant, and so I am not sure what question in Dave's mind I was answering. 'Top to bottom' could be direction, but it could also refer to length. Even when speaking authoritatively as a teacher I was not clear. Violet uses a similar expression:

> each <u>row</u> down, each row from top to bottom.

Here she does mean horizontal 'rows'; 'from top to bottom' means 'all of them' rather than the direction in which a row runs. She is less sure of 'column':

> So I used all these four numbers in the (.) column (.) is it? is that the word to use? In the <u>grid,</u> in the grid, in one grid.

The group all worked hard on establishing common terminology. I will now look at some of the terms adopted by the group.

3.3.4 Criss-cross

Dave used 'criss-cross' in his writing, the first to be read aloud. It became the standard group usage, so much so that I used it to define 'diagonally':

> I think the arrows mean you were going this way, diagonally somehow, criss-cross somehow.

Though Violet uses the formal term *horizontal*, she adopts *criss-cross* rather than using *diagonal:*

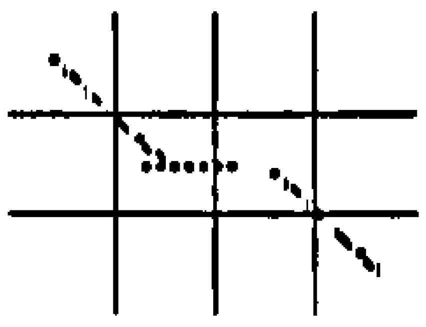
> Were you thinking of it in horizontally, each line, in each grid?

I corrected her, and she said,

> Yes, sorry sorry sorry, horizontally is across. Yes. Vertically, I think he is thinking of it that way, more than (.) even in criss-cross.

3.3.5 A bench, a tunnel maze

These were metaphors for the work Samina did on a 4 by 3 grid (described below). I think the original 'bench' was this:



It was named 'bench' before the taped discussion started; I didn't notice who originated the metaphor. The visual image was so strong that Joyce first remembered it as 'a chair', then amended it to 'somebody did a bench'. Samina's tracing of the route of the line includes 'It goes like this, then this, and then a bench, and then ...' . As she looked at Samina's diagram, Joyce described it as a 'tunnel maze'. We could all see why: a maze because it was difficult to follow, a tunnel because all the lines were funnelled through a narrow centre.

I have given here some examples of the group's efforts to develop a language in common, and illustrations of the difficulties that faced us. The lack of agreed vocabulary sometimes defeated us (though it's unclear, sometimes, whether the difficulty was based on wording or mathematical concept).

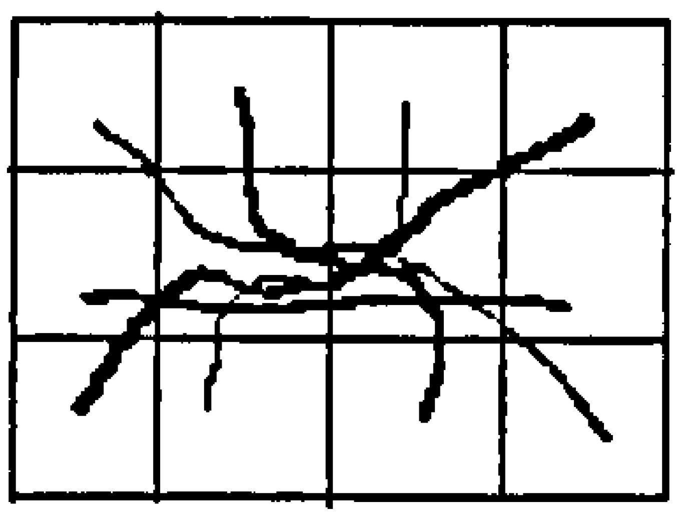
In writing this I have assumed that you, the reader, understand mathematical terms I have used in my own analysis of what students said, including *sum, average, difference* and *common factor*, yet an understanding of the mathematical meaning of these terms is not universal. The terms are available to me, in my own maths discourse, but of course many other mathematics terms are not.

3.4 Waving, not drowning: 'visuals'

So far I have discussed spoken and written language, but language was far from the only means of communication. I imagine that you have had difficulty following the mathematical arguments; the words are thin when removed from other semiotic modes. Here I discuss what Fairclough calls 'visuals', including 'gesture, facial expression, movement, posture' (Fairclough, 1989: 27); he argues spoken texts cannot be properly understood without them. As someone who was present at the discussion, I see the students waving arms and pieces of paper; occasionally people went off into private considerations, muttering and tracing lines on the grid. Further examples are my reliance on facial expressions (Yvonne was looking 'sceptical'), and Dave's standing up to show something to me and Frank. It is possible that we seem to a stranger simply inarticulate, and it is true that we could not express clearly some of our ideas. On the other hand, my perception is that the group discussion was astonishingly *difficult,* and I (who did none) presume the writing was difficult too.

'Somebody did a bench'

Samina did very little 'writing' (in words or numbers) for the project. She did however have a very clear representation in a diagram of her work. She explained her ideas to Joyce, who remembered that 'somebody did a bench'. (Here I have separated the numbers from the grid for the sake of clarity; Samina used coloured felt-tips and drew directly onto the grid.)



64	65	66	67
74	75	76	77
84	85	86	87

Samina	This one. It goes like this, then this, and then a bench, and then =
Joyce	= Sort of a tunnel maze. A tunnel maze to get so it goes 74, 65, and then 77
Samina	No, that's not it, like this .. yeah? and the same way, [like these two.
Joyce	Mm hmm.
Samina	and this, straight along this line
Joyce	This line, this line, cross there
Samina	And <u>this</u> goes like this, this, and this, and <u>this</u> one, and it's all the same.

'It's all the same' refers to the sums of the numbers crossed by the four lines she had traced.

Samina was fluent and articulate using the tools she wanted to express herself - she had used coloured pens to distinguish one line from another, and pointed to her text while talking to Joyce. She had made marks on a page, and from the page she 'read' her ideas out aloud. She did this in her second, less fluent, language. She had no difficulty remembering the central points of her work, unlike others who had used words to record their ideas.

All the students used diagrams and symbols (for example, arrows) as well as writing; Samina's is perhaps the clearest example of multi-modality (Kress, 2000), using colour, shape and gestures as well as spoken words. Morgan (1998) reports that she found she needed to extend the analytical tools offered by Kress & van Leeuwen (1996) to make them useful for mathematical texts. Similarly, the New London Group acknowledge that while 'design elements' have been analysed for linguistic design, in other areas, including visual, gestural, spatial and multimodal design, we lack analytical tools (The New London Group, 1996: 79).

I have highlighted several moments in the discussion when we tackled our difficulties in understanding each other's words. Most of the time, however, we did 'understand', or believed we did. I cannot get inside others' heads to justify that statement - but my own feeling as a participant was that we relished discovering new patterns from each other. If we attend to words only, we disguise other means at the group's disposal: the range of communicative practices enabled far greater mutual understanding (for example, 'the numbers go down' is clearer when the speaker runs their finger down the grid).

4 Authority in the classroom

Here I consider evidence relating to authority: both mine, in the senses of overall director and 'an authority' on mathematical questions, and the strength of students' voices in this discourse.

The discussion was erratically peppered with my efforts to control the direction, clarify meanings and organise air time - for example, make sure everyone spoke who wanted to, and prevent overly dominant voices from taking over. For Cazden this is the 'language of control', used by teachers to establish and maintain social relationships in the classroom (Cazden, 1988). The numerous directions scattered through the discussion show my organisational authority. The whole investigation was at my behest, and I was to mark the students' work for external accreditation purposes. Above all, when the students towards the end of the discussion remarked on how far they had pursued the investigation beyond the original questions, I had the authority to say

> You could do what you want, really.

One feature of the discourse of investigative work is that it is *supposed* to blur the two sorts of authority: students are required to ask their own questions and justify their own answers, in a move that attaches 'mathematising' (mathematical authority) to setting agendas (organisational authority). For example, as a mathematical authority I suspect that Yvonne's analysis of a smaller grid, which led to her statement

> *the grid the number in the right hand corner is the number* that *the numbers below it are greater than*

was an excellent example both of specialising (dealing with smaller numbers) and generalising (extending the principle beyond the original grid). Had we read and discussed Yvonne's first, the group might have been able to apply her statement to the 100 grid. We read Dave's first simply because he made the first offer - that is, an organisational principle (students' choices) over-rode a mathematical argument.

Here I focus on mathematical authority, and argue that the comparatively open-ended nature of the investigation, and the use of shared reading, enabled the group to generate a discourse in which the tutor's authority was less direct and the students' authority was greater. I consider three sections of text, though many more illustrate these issues.

4.1 Checking for 'understanding'

The notion of 'understanding' cropped up repeatedly in my questions; I was in effect trying to *control* understanding. It arose first when Dave, having read out some of his writing, said

> So there's a pattern developing, like. You got in the 4 number windows, the answers go up in 20, and .. in the 9 number window, the answers go up in 30, in the 16 number windows, it goes up in 40. And so on, you know? (11)

Dave's '4 number window' was what I thought of as a 2 by 2, or 2^2; '9 number window' was a 3 by 3; 16 was 4 by 4. In my mind the 'pattern developing' connected 2 and 20, 3 and 30, 4 and 40. I didn't myself know whether Dave had the same conception, or whether his pattern was only the increase by 10 (20→30→40). I asked

> What's that 'so on'? Did everyone understand what he was saying there?

Frank said 'yeah'. Alev checked the literal meaning of 'and so on':

> Et cetera et cetera, yeah?

and Yvonne rephrased my question:

> But, ... have we understood his point there?

Later I asked again,

> Does everybody understand what we've read? .. does everybody understand exactly what Dave's saying there?

Joyce answered confidently,

> Yep, well I do.

The problem facing us was how to know that we shared understandings; how could I know what Joyce understood of what Dave said? Throughout, the transcript shows students checking each other's meanings and helping each other explain their ideas - usually the teacher's role.

4.2 'Wrong' ideas

Yvonne had written out two ideas which she later dismissed, and by each she had written the word 'wrong'. The ensuing debate showed the students pursuing Yvonne's and their own ideas, and debating ways of expressing them, rather than accepting my authority as teacher.

The discussion started when Dave supported one of the 'wrong' ideas:

> You said, where you've got wrong, er, row down jumps up by 90, you're not exactly really wrong there, because like if you go to 1, to 91, that's 90. That's a gap of 90 if you're going down, isn't it? So all the rows, like 2 to 92, is 90.

I agreed that Yvonne was not wrong, but praised her use of her notes to recognise an error:

> I would like to say, it's a dead good example of putting something down and then putting *wrong*. I think it's great to do that. It's perfectly alright to put something down and then tell yourself that it's wrong.

Joyce challenged this:

> But then she was right was she? [general laughter]

- the laughter reflecting pleasure in the complications and ironies of the discussion. I responded and tried to move the discussion on to Yvonne's second 'wrong' comment:

> But then she was right, so she was wrong to say she was wrong but she might have been wrong with that second one.

Dave ignored my move and talked directly to Yvonne, making a judgement of his colleague student's work:

> I think you was wrong in explaining, the way you explained it. (2) Like that, you said, um, the row down jumps up by 90

and his intervention led to continuing discussion of Yvonne's first 'wrong' point.

We also spent some time discussing the second, although by then I didn't want to. I was aware of the clock and wanted to move us on (an organisational issue), and claimed that since *I* could not 'see' the correctness of her point, she was, as she thought, wrong (a mathematical issue):

> I think we might have to accept for the time being that she might have been wrong on the second one that she thought she was wrong on, because I can't see it.

In retrospect, reading the transcript, Yvonne's second 'wrong' point may have been right. She had mentioned adding units; the arrows are diagonal; and the sum of the units on both diagonals across the 100 grid is 90. At the time Yvonne was struggling to remember what her statement meant, and Joyce rejected my judgement:

> Where I see it, where I see it, is you work it down, and she gets 90 that way, if you go across, I still think it's 90 there too.

It's a close reading of Joyce's comments that has led me now to a possible understanding of the 90 in question. The discussion continued, but I finished this section by a determined assertion of classroom control. I signed off from Yvonne's work, in a move authorised by the teacher's organisational role rather than by mathematical expertise:

> Ok, I think we should press on, with Violet's, because otherwise we'll be here forever. Thanks very much!

4.3 Confidence in expressing mathematical ideas

Samina was the quietest person in this group. She saw herself as unconfident in maths, and had pressure from home around maths. She was 18 and acting as the female head of the household. Her father tested her in arithmetic every day, and she dreaded it. Her brother, who came over more recently from Pakistan and 'should', Samina said, know less maths, was confident and quick. Samina's first language is Urdu and we had spent some time discussing the Urdu number system. She had particular difficulties with place value arising from important differences between Urdu and English number naming. Through almost all of the 100 grid discussion, she said nothing. She was sitting at one end of the table, clearly following the discussion, but not contributing. I have however quoted above her very confident exposition of the patterns she had drawn; I had never heard her express an opinion so confidently in the class. I would suggest her confidence came from having a way to communicate her ideas that did not depend on written or spoken English, in a discourse in which 'right' and 'wrong' were up for debate.

4.4 A shared discourse

So far the group's (including my own) use of deictic markers (Hatch, 1996) - *this, it, that one, across there, top to bottom* - has been part of my evidence for the difficulties in being sure of shared meanings. Hatch defines deictics as having a 'pointing' function in a given discursive context; if what is pointed to is unclear, a text is ambiguous (Hatch, 1996: 209-210). In the detail of much of the 100 grid discussion, that is a fair reading. But I want to contrast it with James Gee's analysis of a speaker's use of pronouns. The speaker is

> *treating [the hearer] as someone who shares knowledge with him and who is part of the overall task. He is ... signaling that he takes the text he is orally constructing to be a continuous and integral part of the whole task starting with the reading of the story and instructions, through the group discussion, and ending with his summary. (Gee, 1996: 173)*

That is exactly what happened here. We 'construed the context' (Gee, ibid.) as a shared endeavour. Students and tutor alike were absorbed in the investigation and there is a sense - for example, from the number of interruptions - of urgency and commitment, and hence the need to express an idea quickly, before it disappeared, using whatever words or gestures we could to understand others' ideas and get our own across.

My authority throughout the discussion is less direct, obvious and immediate than is usual in my experience, and the students' authority is greater. I cannot make a final judgement on where this comes from, since there may be other discourses at play than those visible to me, but I would suggest that investigative work, initiated by my questions but encouraging students' own enquiries, led to a classroom discourse in which the students are searching for agreement not only from the teacher for their suggestions, but from each other.

Reading aloud from previously written work, and sharing diagrams, created a shared ground from which to develop a discourse. As I argue in Chapter 8, work that is in some ways 'set' by students generates a collaborative discourse; the authority of the teacher or the textbook is decentred by basing work on students' own questions.

I don't want to deny my position as tutor gives me considerable control in the group. Nevertheless, investigative work and reading their own writing as a basis for discussion freed up some space for the students to take a lead.

5 Summary and themes

The key themes from this chapter all relate to strengthening students' voices. I discuss this in terms of students' positioning as investigators; unsettling classroom discourse; and life in numbers, a challenge to the division of mathematics into everyday/concrete and meaningless/abstract categories.

5.1 Students as investigators

The 100 grid discussion was taped for my research purposes, not students'. However, the discussion has close links with features of the participant research discussed throughout this thesis, and I argue these arise from positioning students as *investigators.* Research into the 100 grid structure, an apparently dry set of empty numbers, generated collaborative work and exposure of authority processes. The class was based on the use of students' writing and their own questions as learning materials - and in this is similar to other work discussed in the thesis (particularly in Chapters 8, 9 & 10). Rather than positioning students as already more knowledgeable than the tutor/researcher (as the conference organisers in Chapter 9 are positioned), here the discourse of investigation placed students and tutor if not on an equal footing, at least in a space where genuine inquiry from all was the basis of the class. There was no textbook to give the answers (or if there was one, the tutor hadn't read it...).

5.2 Unsettling discourse

I have throughout the thesis used the expression 'unsettling discourse' (taken from Ellsworth, 1992) as a metaphor for shifts in classroom discourse supporting and evidencing the strengthening of students' voices - one of the key themes of this thesis.

This chapter has shown students determined to communicate mathematical ideas with each other by whatever means available. That is founded in part on an interest in the mathematical structure itself, and I come to that in the final section. Here I remind us of the particular discursive practices at play.

The discourse was generated in a collaborative, familiar group. In 'reading aloud' we can see students amending as they read; re-interpreting their own or someone else's written text in their own voice; changing a mathematical report into a personal narrative; changing and creating mathematical ideas. By the end of the reading out, the text has been transformed and the shared mathematical experience of the group is far beyond what was written down. It seems that at least part of the value of 'writing about maths' is that writing produces something which can be read and argued over. The live, real, known and supportive audience (as opposed to the imaginary audience advocated by some proponents of writing-to-learn, and critiqued by Morgan, op. cit.) contributed to the oral changing of the texts into more personal narratives; the 'reading aloud', then, is a reading aloud in a particular context.

But we have seen that students did not only communicate through spoken or written words. That is the case in any exchange (Fairclough, 1989) but the mix of communicative modes in this class was particularly rich. This too arose from the particular context and purposes: commitment to the investigation and the determination to communicate ideas when words were inadequate.

I would argue that the group's work shows that we can make little progress by analysing writing, calculations, talk or gesture in isolation. If we are to support students' expression and development of mathematical language then we need to develop access to a rich mathematical environment which recognises the interconnections of speech and writing, mathematical patterns and the space in which we wave and point. In reading the transcript, the group said they found it hard to follow because the talk is detached from the writing, body language and gesturing. This is a pointer to a possibility for development. We have seen that Yvonne, Dave and Violet all showed (self) critical awareness of their writing, and Violet raised the question of appropriate terminology within the genre: 'you have to use the right word for maths'. Morgan (1998) suggests that teachers and students need access to the analytical tools offered by discourse analysis (e.g. Fairclough, 1992a; Halliday, 1985; Kress & van Leeuwen, 1996). Extracts from transcripts such as this one could provide a route into two discourses: a) that of discourse analysis itself, so students could discuss and elaborate their uses of metaphor and spatial representation, for example, and b) the discourse of more formal description of mathematical objects (for example, factors and sums). Discussion about this within the field of critical discourse analysis would suggest critical introduction of specialised mathematical terms, rather than a bald 'teaching' of them, isolated from particular contexts.

A further value in such a development would be the opportunity for students and tutors together to analyse and debate each others' interventions in terms of authority, both organisational and mathematical. We could, for example, compare the uses here of 'right' and 'wrong' with Cindy's statement (Chapter 4) that 'in maths you're either right or wrong'.

5.3 Life in numbers

In the introduction to this chapter I quoted Valerie Walkerdine and Roseanne Benn raising questions about the relationship between maths and society - Walkerdine in terms of an abstract/concrete distinction, and Benn in terms of a meaningless/real distinction. I want to challenge those distinctions.

In working on the 100 grid, a 'meaningless, made-up problem' in Benn's terms, we entered an enveloping three-dimensional world. The grid, lines, columns and numbers became active agents which move and jump; the grid contains chairs, benches, a tunnel maze. In the whole transcript there is no moment at which we are not focused inside this world; we were totally absorbed. (Jane Mace writes of 'literacy's transports' in her description of reading as a way of removing oneself from the immediate here and now (Mace, 1998); here we have the 100 grid's transports.) The evidence for this is in the transcript and my own memory of the classroom, but there are too some comments from students celebrating their intellectual and emotional engagement. Joyce said writing about the 100 grid

> *help you to think, concentrate more. It helps you to think, because numbers are very funny, you has to know what you're doing with numbers, to (.) get it in the right perspective...As you [Alison] once said before, it's no point doing something you can (.) you already know how to do. So (.) this is a sort of a challenge.*

Frank said about the writing,

> *but it needs a good person with a good brain who could do it yeah?*

The students were engaged with each other's work, challenging and amending it, but there is also a strong sense of independence:

> *Have you noticed what we've all done? We've all done something differently from what the paper says. What happens when you add up the numbers? [quoting the worksheet] But we've all sort of do (.) different things, like multiplying it, dividing it. (Dave)*

The investigation demanded intellectual commitment and sustained effort. The 100 grid has nothing to do with the 'real world' as commonly defined; it is highly abstract. However, the 'real world' notion needs challenging: this classroom *was* the 'real world'. Jean Lave suggests we move away from division in maths discourses between the 'everyday' and the 'theoretical', preferring a distinction between things that do and do not engage learners (Lave, 1992: 88). In the 100 grid investigation, every student was actively engaged in the discussion, and there were moments of passion in their arguments. The grid loses its abstraction and becomes a concrete (and active) world.

The students in this group were all working class; four were settlers from former colonies (Pakistan, Jamaica and Ghana) and one from Turkey; five were women, two men; one had learning difficulties and schizophrenia. All depended on benefit (three of them because of their own or their children's disabilities). Hence I would argue all had 'a life in which it is materially necessary to calculate for survival', as Walkerdine puts it, yet they engaged passionately in 'calculation as a theoretical exercise'.

The 100 grid is self-contained, self-referential - but that is not the same as abstract or meaningless. It became concrete and had meaning - indeed, came alive - in the course of students' work on it. Its meaning is not inherent, but is generated in a discursive setting. This contributes to other evidence in this thesis (particularly Chapters 9 & 10) that to define adult basic education students' maths only in 'real life' and 'everyday' contexts is not only an unnecessary restriction of their access to maths; it depends on dominant discursive views of what those 'real lives' are like. It therefore positions ABE students as, I suspect, Walkerdine might - poor, colonised, struggling to survive.

It's impossible to tell what's 'really' happening, of course. All of this is in a context in which students' chances of jobs are supposed to improve if they get qualifications in maths, so their choices within maths are constrained by outside demands as well as by their own maths skills and the tutor they work with; I cannot know all the discourses which impact on students' engagement with maths. Nevertheless, I would argue that for this particular group investigative work gave access to a constructive, mutually supportive and emotionally and intellectually engaging maths discourse in which student voices were powerful.

Chapter 7: How do you do maths? Algorithms and the empty number line.

1 Introduction

The chapter offers evidence for several of the themes of the thesis: the complexities of discourse in maths classrooms; the contradictions in dominant discourses' split between 'meaningless' academic maths and 'everyday' maths; the possibility of productive work in classroom discourse analysis for both tutors and students; and the generative work of student co-researchers. Although other chapters (particularly 6 & 8) discuss maths work in some detail, this is the only one to focus in detail on ways of calculating, and will I hope contribute to a more textured picture.

During a conversation about how the research project was going, Sandra said she would ask fellow students (from both English and mathematics courses) 'how they do maths'. Her initial plan was to ask people about all four operations; she started with subtraction, and what is presented here includes data she collected on five people's algorithms: her own, mine, and three others' (section 2). They are contrasted with work on the 'empty number line' (Beishuizen & Anghileri, 1998), a comparatively unstructured approach which may support the development and discussion of mental methods (section 3).

2 How do you do maths?

Sandra's question was 'How do you do maths?', and her choice of the four operations as the basis for data collection could be interpreted to show a narrow view of mathematics as a set of computational routines. She was, however, an organiser of the students' conference and magazine (Chapters 9 & 10), both of which addressed much wider issues. It may be that our discussion of how the research was going led her to think that 'real' maths (calculation) was being underplayed. Sandra's work led me to a more detailed consideration of written algorithms and the associated patter than I would otherwise have engaged in; I am using Sandra's data (though I was closely involved in the process) to address her, rather than my, question, and in that process my own questions have been expanded.

Sandra asked me to write down 'what they say' as people worked on the subtraction sums (meaning written calculations, not necessarily addition), and to type up what I had written, with some of her own comments about how to do the research, and copy it with the sums. As far as possible I wrote down exactly what I heard. Sandra then circulated my typed version around the education centre. This is a copy of what she circulated (originally A4, double sided):

How do you do maths?

Notes of a discussion between Sandra and Alison, 2 March 1998

We agreed we would talk to students in Bede, even if they are not attending maths. Ask questions! Carry a little notebook around. We could ask them four ordinary sums, and some problems, and ask them,

What way would you do the sum?

We started with this one:

426-328

Sandra said, 'Oh, that would be a problem seeing it like that', and set it out with the 328 underneath the 425.

This is what Sandra says to herself as she does it:

8 from 6 I can't do.
Go to the bank.
8 from 16, and pay one back to the bottom number.
I ask myself 3 from 2, I can't do.
So I go to my bank again.
I put 3 away from 12 now, 9,
and pay one back.
And then the third row I add the 1 to the 3,
so it's 4 away from 4 is nothing,
so it's 98.

$$\begin{array}{r} 4\,2\,6 \\ -\ 3\,2\,8 \\ \hline 0\,9\,8 \end{array}$$

Margaret joined in the discussion. She puts the minus sign on the left hand side. She says:

8 from 16,
I borrowed a 10.
Then I cross the 2 out and put a 3.
I borrow another 10,
so that's 3 from 12 is 9.
Cross that 3 out, put a 4,
and 4 take away 4 is nothing,
so the answer is 98.

$$\begin{array}{r} 4\,2\,6 \\ -\ 4\,\cancel{3}\,\cancel{2}3\,8 \\ \hline 9\,8 \end{array}$$

Alison does it more like Sandra, though the 'pay back' ones are to the left rather than the right of the number they are added to.

$$\begin{array}{r} 4\,{}^{1}2\,{}^{1}6 \\ -\,3_{1}2_{1}8 \\ \hline 9\,8 \\ \hline \end{array}$$

Sandra said she thought Antoinette did it like this:

$$\begin{array}{r} {}^{3}\cancel{4}\,\overset{11}{\cancel{2}}\,{}^{1}6 \\ -\,3\,2\,8 \\ \hline 9\,8 \\ \hline \end{array}$$

Jenny says

I need to take 9 away from 8 and you can't do it.
So I look at what I've got here
and it's 40.
So I make that into 39,
and I put 1 there.
So now I've got 9 from 18
which is 9.
6 from 9 is 3,
and 2 from 3 is 1.

$$\begin{array}{r} {}^{3}\cancel{4}\;{}^{9}\cancel{0}\;{}^{1}8 \\ -\;2\;\;6\;\;9 \\ \hline 1\;\;3\;\;9 \\ \hline\hline \end{array}$$

The minus sign.
Sandra thinks Ann puts the minus sign on the right hand side, and Sandra puts it on the left. Margaret puts it on the left. Sandra said when she sees Ann doing take away sums

> I'm looking at that line,
> it's foreign,
> it's in the wrong place.

In describing students' work, I have found few tools for the description and analysis of graphical representations (cf. Morgan, 1998) and of 'patter'. I use the term *patter* for the standard recitation that accompanies working through an algorithm. It is often spoken aloud, particularly when showing a tutor how a problem is worked, and is almost certainly an integral part of the algorithm. Patter depends, I think, on auditory memory; for example, someone interrupted in the middle will often go back to the beginning, in the same way that someone using alphabetical ordering may 'take a run' at the middle of the alphabet by starting from the beginning. Tom Lehrer's (1965) comic song on 'new math' depends on the familiarity of the subtraction patters. As I shall do, Lehrer comments on the age of his audience, as they split between decomposition and equal addition methods. The New

London Group (1996)note that 'design elements' for visual and audio areas of discourse remain to be detailed. Roseanne Benn's survey of adult numeracy work and research in Britain (Benn, 1997b) discusses the use of context and abstraction, but does not consider algorithms in any detail. Alrø & Skovsmose (1996) discuss 'students' good reasons' (for apparent errors) within mathematical understanding, context, organisation of the classroom and personal experience, without consideration of the detail of calculations.

2.1 Two methods for subtraction, or five?

Two apparently standard algorithms were used here for subtraction: *decomposition* and *equal addition.* The initial layout, in columns, is the same; they vary in how to deal with situations where the digit in the top line is smaller than the digit in the lower line. Both are described in detail in a pack by Diana Coben & Sandy Black, a standard adult mathematics classroom text, which I and the students often use.

Equal addition is called the 'borrowing method'. Coben & Black give the patter for the algorithm:

$$\begin{array}{rr} & \text{TU} \\ & 4\,^{1}3\ - \\ & \underline{^{1}2\,6} \\ & \underline{1\,7} \end{array}$$

> This is one way of doing take-away sums.
> Start from the right hand side as usual.
> Say **3 - 6** you can't do it.
> So borrow from the tens column.
> You need to borrow **1** lot of ten.
> Put the **1** next to the **3** to make **13**.
> Now say **13 - 6 = 7**
> Write the **7** down under the units column.
> You need to pay back the ten you borrowed.
> Remember that, back in its own column,
> the ten is only worth **1**
> So put **1** next to the **2** to make **3**
> Now say **4 - 3 = 1**
> Write the **1** down under the tens column.
> You've done it. The answer is **17.** (Coben & Black, 1984: Book 2, p. 8)

The *decomposition* method depends on 'decomposing' the number in the top line. One of the Coben & Black examples shows the working for 307 - 49:

$$\begin{array}{ccc} ^{2}\cancel{3} & ^{9}\cancel{0} & ^{1}7\ - \\ \underline{} & \underline{4} & \underline{9} \\ \underline{2} & \underline{5} & \underline{8} \end{array}$$

For this method, Coben & Black do not give a 'patter'. The explanation is summarised like this:

307 = 300 + 7 = 200 + 100 + 7 = 200 + 90 + 17 (p. 10)

Their written calculation does not show the third step, *200* + *100* + *7*, though it is included in the explanation. Many students do include this third step in their working out, leading to messier crossing out in the final stage:

$$\begin{array}{rrr} {}^{2}\cancel{3} & {}^{1}\cancel{0} & 7 \\ - & 4 & 9 \\ \hline \end{array} \quad \text{Third step} \qquad \begin{array}{rrr} & 9 & \\ {}^{2}\cancel{3} & \cancel{{}^{1}0} & {}^{1}7 \\ - & 4 & 9 \\ \hline 2 & 5 & 8 \\ \hline \end{array} \quad \text{Last step, and solution.}$$

In omitting the patter for decomposition, Coben & Black illustrate a key difference between the two methods. Equal addition is an entirely closed and complete algorithm. It works every time, if applied correctly; there are no choices for the solver. Decomposition is an algorithm which, proponents would claim, supports and depends on understanding of place value, but which is harder to work. There is a particular problem if there is a zero in the top line (we shall see Jenny's way of dealing with this, below), and the lack of a standard patter reflects this 'zero' problem. The more a method demands understanding, the less easy it is to make it into a fixed algorithm, which is valued precisely because it stops you having to think.

Of the examples that Sandra collected, the first three, Sandra's, Margaret's and mine, are all 'the same', in that they use the equal addition algorithm. The last two, Antoinette's and Jenny's, both use the decomposition algorithm. The age of the solvers may be relevant: Sandra, Margaret and I are significantly older than Jenny and Antoinette, and our methods are probably defined by methods used in primary schooling (though Sandra adopted an idea from her husband, discussed below).

When I group the five solutions into two methods like this, I am using teachers' categories. Sandra and Margaret initially saw these solutions as *five completely separate* ways of solving subtraction problems. Indeed, Margaret wanted to show her method *because* it is different from Sandra's. I go on to explore these differences.

2.2 Visual cues

When Sandra first raised this proposal for research, I wrote down notes while we talked. I deliberately wrote her proposed subtraction problem ('four hundred and twenty-six, take away three hundred and twenty-eight') horizontally (426 - 328) because I didn't want to prejudge how people would tackle it (and it might be manageable by mental methods, for example). Sandra said, 'Oh, that would be a problem seeing it like that', and argued it would prevent people knowing what to do. When she asked others to try it, she had already written it out in columns, because it would be too difficult otherwise. I commented that how it looks seems to make a big difference to her. She said one of her tutors put the minus sign on the right hand side: 'I'm looking at that line, it's foreign, it's in the wrong place'. So at least to Sandra (who has sight disabilities and is dyslexic) the layout is crucially important, in every detail. The Coben & Black pack is popular with tutors for its large print, limited demands on reading skills and clarity of explanation. I now notice that it consistently shows the + , - and x signs on the right hand side; before Sandra's research, I would not have noticed the placing of the signs at all.

2.2.1 Differences in 'paying back' layout (the equal addition method): Sandra, Margaret and Alison

When Sandra 'pays back' one 'to the bottom number' she writes down *1* and mentally adds it to the existing number (so in her example of 426-328, she follows Coben & Black in writing a small 1 next to the 2 of 328, and mentally making that 2 into 3). Watching this, Margaret said she did it differently. She crosses out the existing number and replaces it with the number increased by one. They asked me to do my version; I said it was the same as Sandra's, and wrote it down, but when Sandra looked at it she said my 'pay back' ones are in a different place from hers (to the left rather than right of the 'bottom number').

2.2.2 Zero in the far left place

Sandra writes down a zero in the hundreds column (so that her answer is *098*); Margaret and I (and Jenny and Antoinette, using the decomposition method) all leave it blank. Although Sandra noticed the placing of the 'paid back' 1s, which seems to me to be a very minor difference between her and my layouts, she did not comment on the absence of the zero in the hundreds place in my or Margaret's version. I mentioned it myself; she said she had always put it there, and she does know it's not required for a correct answer. (One of my reasons for raising the question is that some students write in the zero and then are not sure how to read the number.)

2.2.3 Differences in decomposition - one column or two at a time?

Jenny volunteered her method, a shortcut version of decomposition. The example she chose, 408-269, had a zero in the top line. This can lead to the repeated crossings out mentioned above.

Jenny avoids that by dealing with the 4 hundreds as 40 tens: 'So I look at what I've got here and it's 40. So I make that into 39, and I put 1 there.' Note that I have identified the 40 as 40 *tens* in order to explain Jenny's method; it's possible that she thinks of it just as 40. Sandra watched and listened to this, and said 'I think Antoinette changes the top line, but I'm not sure what she does'. I wrote out the original problem (426 - 328) and showed the 'standard' decomposition method; Sandra later discussed it with Antoinette who confirmed that the layout was right.

2.2.4 *Visual clues in other calculations*

When I asked Sandra about her use of zero in her answer (098), she said she also uses them in addition. She showed me 3087 + 134 as an example. She lays it out in columns:

```
 3087
+ 134
```

Zero
goes
here

She says:
4 and 7 is 8, 9, 10, 11.
Put down 1 and carry 1.
1 and 3 is 4.
4 and 8 is 9, 10, 11, 12 and we're off again
onto the next column.
1 and 1 is 2
and I just see a 3 there. I put a zero there,
so that's 3 in the answer.

```
£ s.d.
3.45
x 20
```

When working on multiplication of money, Sandra heads her columns £ *s. d.* (pounds shillings pence), because it helps her keep the figures in columns. Putting p (for pence) is no help because it is one letter only, and she needs guides for two columns. This causes her no problems at all in understanding the meaning of the calculation (and she uses a decimal point between the pounds and shillings columns in the solution); the £ *s d* headings are a graphical rather than semantic aid.

2.3 The patter

Patter seems similar in some respects to the way that some children can recite the *Lord's Prayer* in obsolete English, or sections of the *Qur'an* in classical Arabic, without understanding what it means. On the other hand, the algorithmic patter *does* have a clear meaning in that it contributes to production of an accurate solution, even if speakers cannot 'explain what they mean'.

We have three people's subtraction patter. I have broken them down into stages so we can compare the wording.

426 *<u>-328</u>*	*426* *<u>-328</u>*	*408* *<u>-269</u>*
Sandra (equal addition)	**Margaret** (equal addition)	**Jenny** (decomposition)
8 ***from*** *6*	*[Misses out '8 from 6' stage]*	*I need to take 9 away* ***from*** *8*
I can't do.	*8* ***from*** *16,*	*and you can't do it.*
Go to the bank.	*I borrowed a 10.*	*So I look at what I've got here, and it's 40. So I make that into 39, and I put 1 there.*
8 ***from*** *16. [Wrote down 8, but didn't say this out loud.]*	*[Wrote down 8, but didn't say this out loud.]*	*So now I've got 9* ***from*** *18, which is 9.*
and pay one back to the bottom number.	*Then I cross the 2 out and put a 3.*	
I ask myself 3 ***from*** *2 ...*		
...I can't do.		
So I go to my bank again.	*I borrow another 10*	
I put 3 away ***from*** *12 now, ...*	*so that's 3* ***from*** *12 ...*	*6* ***from*** *9 ...*
...9...	*... is 9*	*... is 3*
and pay one back.		
And then the third row I add the 1 to the 3, so ...	*Cross that 3 out, put a 4*	
it's 4 ***away from*** *4 is nothing.*	*and 4* ***take away*** *4 is nothing,*	*and 2* ***from*** *3 is 1.*
so it's 98.	*so the answer is 98.*	

2.3.1 From, away from, take away

There are two common models for 'taking away'. In the example '9 - 6', most people say *9 take away 6, 9 minus 6* or (rarely) *9 subtract 6*: the 9 is named first, and the problem is 'read' from left to right. However, in a vertical layout like (a),

a) 29 - <u>16</u>	b) 26 - <u>19</u>

people may say '9 take away 6' *or* '6 from 9'; they usually start on the right, but may use the top or bottom line as the starting number. I have worked with many students who have difficulties with this, and who when faced with problem (b) may still say '6 from 9', thus getting the incorrect solution 13. Sometimes if I point out the error, the student recognises it as such. Sometimes it is deliberate: the student has seen that you 'can't' take 9 from 6, and reverses the order 'to make it work'.

Margaret, Jenny and Sandra use 'from' (and Sandra also uses the variant 'away from'). These are in bold in the table. At the last stage, however, in the hundreds column, Margaret changes order and says '4 take away 4'. I don't know whether this is particularly important or significant to these three solvers. No-one commented on it; my own interest comes from working with people who reverse order wrongly, as in example (b), rather than correctly.

The wording used by these solvers is listed here, using the example 10 - 8:

Put 8 away from 10	Sandra
Take 8 away from 10	Jenny
8 from 10	Sandra, Margaret, Jenny
8 away from 10	Sandra
10 take away 8	Margaret

None of the three uses the supposedly 'standard' maths terms *minus* and *subtract.*

2.3.2 Going to the bank, borrowing, paying back

Sandra says, '8 from 6 I can't do. Go to the bank'. When Margaret and I laughed at this, she said her husband suggested it as a way of remembering to 'borrow'; it would be more memorable because money matters. What she takes from the bank is unclear: it may be a 1, *put next* to the 6 to get 16, or 10, *added* to the 6 to get 16 (and the change from 2 to 12 in the tens column is similarly ambiguous). Margaret borrows 'a ten' when dealing with the units column, but also when dealing with the tens column, when it could be 10 units (10 + 2 = 12) or 10 tens (10 tens plus 2 tens = 12 tens). Sandra 'pays one back'; Margaret does not use that phrase.

Jenny seems to deal with numbers as they read: 'I look at what I've got here [in the hundreds and tens columns] and it's forty. So I make that into 39, and I put 1 there [to the left of the units 8]. So now I've got ... 18'. Jenny doesn't use the term 'borrow', but many people using the decomposition method do; alternative words are 'take' and 'use'.

'Borrowing' has become a naturalised part of the subtraction patter (along with *carrying* in addition, multiplication and division). It's not a very accurate metaphor. As a child (using the equal addition algorithm) I puzzled over 'borrowing' but not *from* anywhere (nothing was reduced), and then 'paying back' and a number made a gain, i.e. two numbers both increased. It is perhaps useful to say 'borrow' rather than 'take' or 'add' (which might be confused with subtraction or addition); and it does imply some sort of compensation for the changes made. The oddity of 'borrowing' is pointed up by Sandra's elaboration of the metaphor into 'going to the bank'. To her, going to the bank is a fixed part of the patter. We could regard this simply as eccentric. However, the fact that both Margaret and I seized on it as an oddity shows up the extent to which we both expect the patter to be more or less identical for each solver, and no longer see 'borrowing' as a metaphor; it has become a reality.

2.4 Comparing methods: facilitating learning or just confusing?

My own subtraction patter was much like Sandra's, except that I 'borrowed' instead of going to the bank. Despite that, she saw my way of doing the problem as significantly different from her own, because my 'paid back' 1s were in a slightly different position. She finds subtraction problems very much harder if the sign is put to the right instead of the left of the numbers. She inserts a zero (into both addition problems and subtraction solutions) to make the columns 'look right'.

All the students see very significant differences between their methods, suggesting that a tutor's categorisation of methods may not be enough for teaching purposes. To note to myself 'uses decomposition' is not enough to define which layout or patter will look or sound familiar to a student; my own view of the conceptual differences in algorithms is not the same as the students'. I imagine this is more of a difficulty for adults than for children; a 50 year old may have had over 40 years of doing subtraction in the same way.

There are several reasons for suggesting sharing methods:

- in a large group, the students will need to support each other. A discussion about people having different methods may help both students and tutors to work with each others' methods rather than imposing our own;
- some methods are more efficient than others and some work better with particular problems than others. Comparing methods, and trying out new ones, might help people to develop a sense of choice and control;
- some of the students who have no experience of written algorithms have good mental methods, and such discussions give them an opportunity to join in a whole group discussion with some confidence.

On a separate occasion I asked a group of 11 students to talk through how they did a subtraction problem (including mental methods). (A different) Jenny said, 'Oh, I'm not listening, it's confusing me' when others explained decomposition (she uses equal addition). I don't think her grip on how to subtract was at risk (she seems confident and consistent); it seemed that it was *too difficult* to understand someone else's method because every step jarred. Sandra says that small visual differences make algorithms look 'foreign', but she enjoyed her work on others' algorithms; I imagine that had she been trying to find a solution to a problem - that is, *use* rather than *explore* a different algorithm, she would have had difficulties.

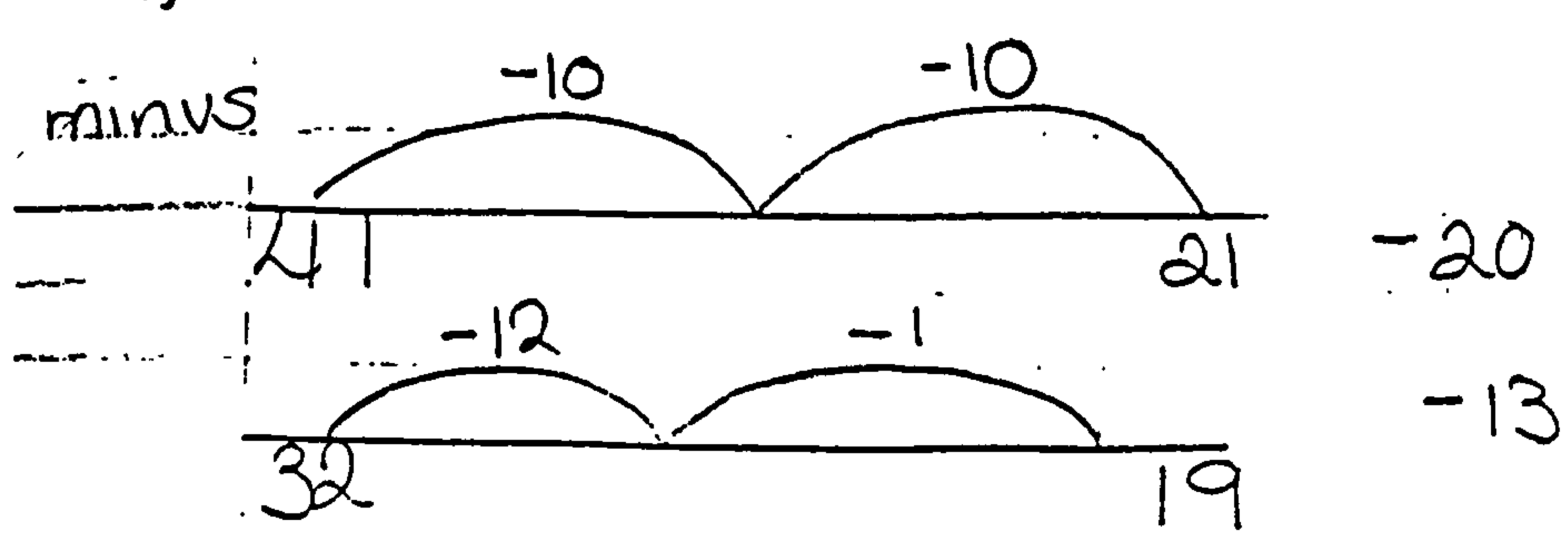
One reason for the power of an algorithm, both visual and verbal, is that you don't have to think. Sandra's research shows that we need to be aware of the importance of detail in what makes an algorithm. A student may have to work harder than we imagine in order to follow a tutor's, or other student's, use of what she thinks is the student's method, and similarly as tutors we need to pay more attention to the minutiae of algorithms before we claim 'understanding' of the student's methods.

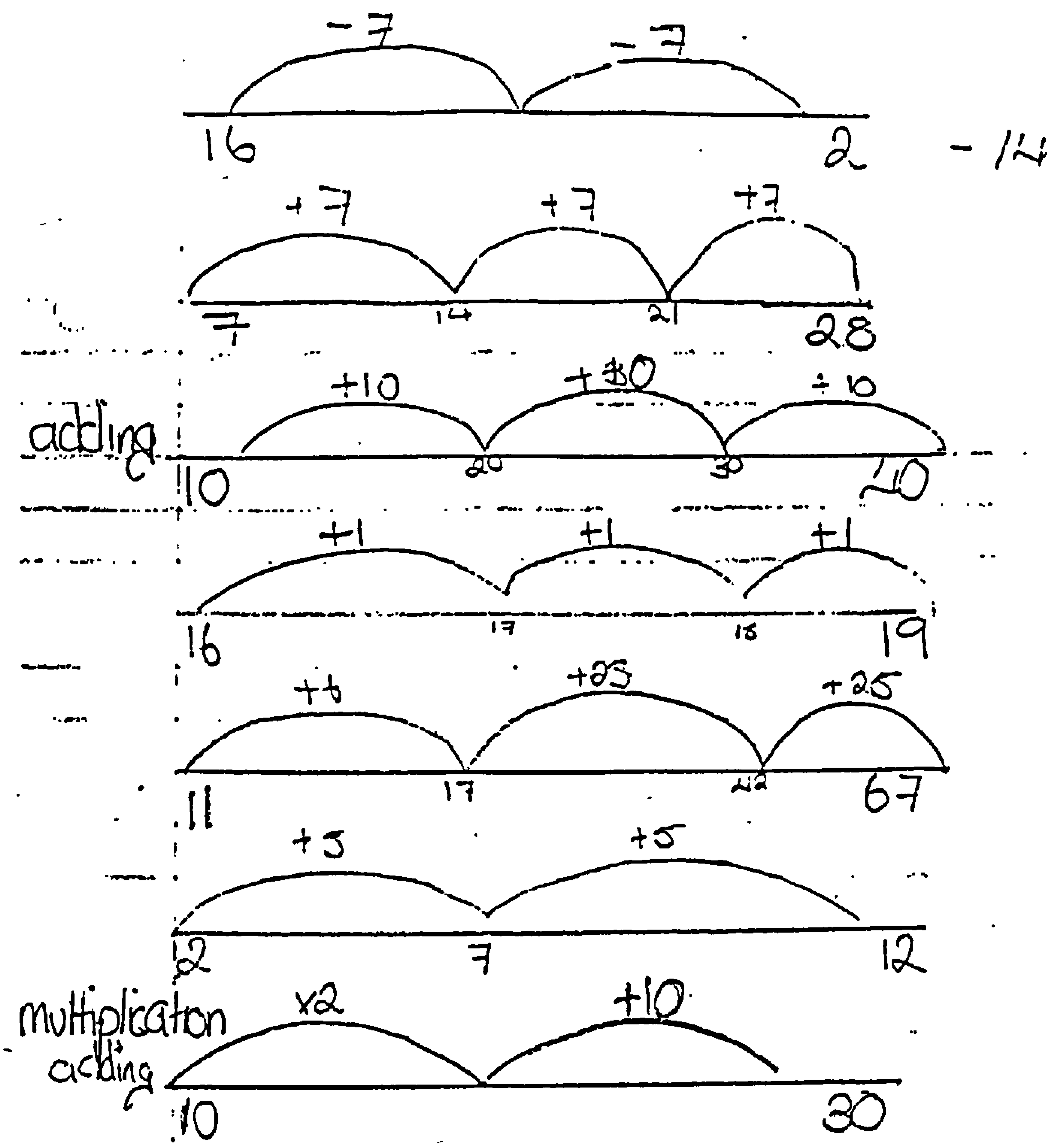
3 Trying new methods: the *Empty Number Line*

Several students tried the 'Empty Number Line' (ENL) (Beishuizen & Anghileri, 1998) approach. It is not an algorithm, since it supports a wide range of different strategies, but on the other hand it *is* a form of standard layout. Part of the worksheet the students used is Appendix 7; it incorporates the Dutch *Difference problem: 'Leiden on Sea'*, with three Dutch school students' solutions, with further examples of use of the ENL on the reverse. All the students to whom I offered it were willing to give it a try, and some found it helpful.

They started by working out what Wilco, Eddy and Brit, the Dutch students, had done, and then checked that they could also follow the examples on the reverse of the sheet. The Dutch students have (as far as we can judge) quite different strategies; for example, it looks as though Eddy works from left to right, Brit from right to left then right again, and Wilco possibly either direction. I have no record of people's verbal explanations, to themselves or for others, of how they themselves used the ENL. Sandra and Tracy both set their own problems and worked independently. 'Setting problems' may not be an accurate description of how they set about using the ENL; certainly for a reader the 'problems' and 'answers' are not easily distinguishable. I will look at Tracy's first.

3.1 Tracy





Tracy labelled her work in three sections, *minus*, *adding* and *multiplication adding*. The *minus* section's first problem shows the 41 to 21 stretch of the number line; she puts 41 at the left (unlike the Dutch students, who put smaller numbers to the left), and counts along two lots of 10 to get to 21. The apparent 'answer', *-20,* is on the right. This could be then the solution to 'what do you do to 41 to get to 21?' The second number line shows the gap between 32 and 19, again with the higher number on the left; the steps are -12 and -1, giving -13 as the answer. It looks then as though Tracy is 'reading' or 'writing' the number line from left to right for purposes of subtraction, so that '41 - 21' (or 41 - 20; it's not clear which calculation is being done) reads left to right with the bigger number on the left, and that is reflected in the number line.

Tracy's third and fourth lines are marked in 7s. The third goes from 16 on the left to 2 on the right, with the answer -14. It would seem more usual to go in steps of 10: either down to 6 and another 4 to 2, making 14, or down to 10 and then to 2, steps of 6 and 8 together making 14 (these are two of the Dutch approaches Tracy had read). I can only speculate, but it seems likely Tracy knew, in her head, that the answer was 14, identified that as a multiple of 7, and was experimenting with ways of using the number line. The fourth line seems to confirm this: the direction of the line changes, going from 7 on the left up to 28 on the right, and is drawn in steps of 7 again.

The rest of her examples all run from a smaller number on the left to a larger number on the right; she may have fixed on this as the easiest way to 'see' or 'read' the line. Her seventh and last examples are curious. In the seventh, she goes from 11 on the left to 67 on the right, in steps of +6 (to 17), +25 (to 42) and +25 (to 67). The sum of +6 +25 +25 is 56, the difference between 11 and 67, but she has not written that 'answer' down. Why steps of 6, or 25? Neither is specially 'round' or 'easy' (though 50 (two lots of 25) is probably more so); nor are the points on the line (17 and 42) obviously easy.

Tracy's last problem is labelled 'multiplication adding', and goes from 10 to 30 in two steps, x 2 and +10 (the 20 mark on the line is not labelled). In both these problems, she seems to trying out what she can do with the ENL rather than seeking to solve 'a problem'.

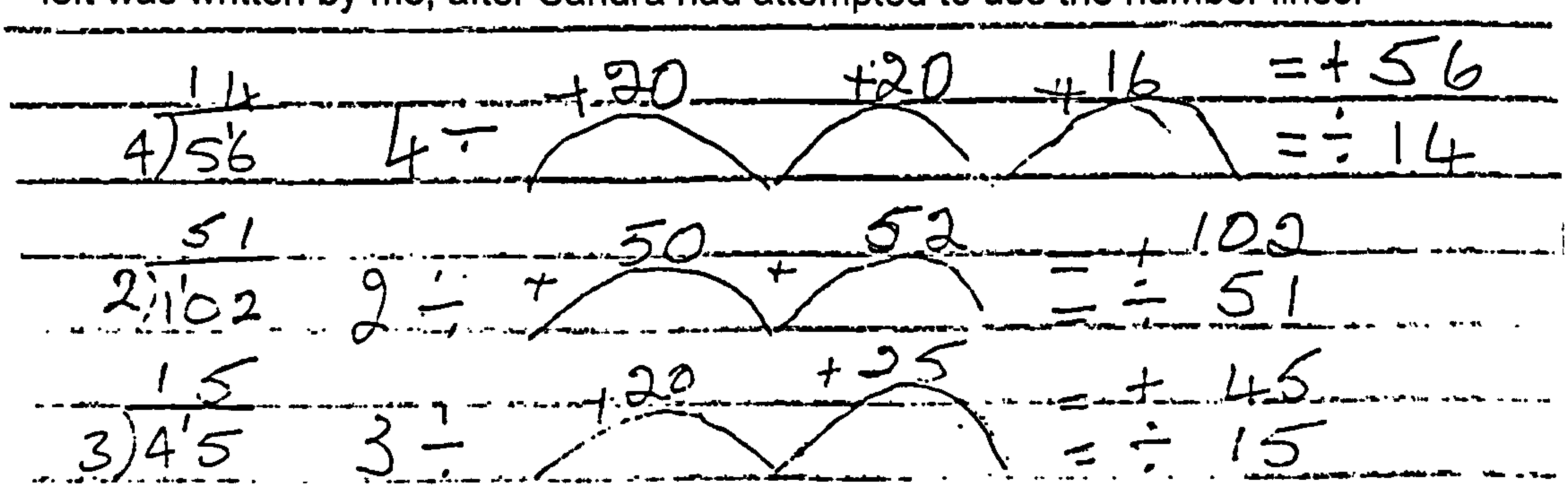
The worksheet states that 'the line can be used for adding and taking away', and asks 'Can you find a way to use it for division or multiplication?' Tracy was perhaps showing ways to use the line for multiplication. It does show division too (for example, *how many 7s are there between 7 and 28?)*, but I doubt if Tracy meant it to, since she does not label anything as division.

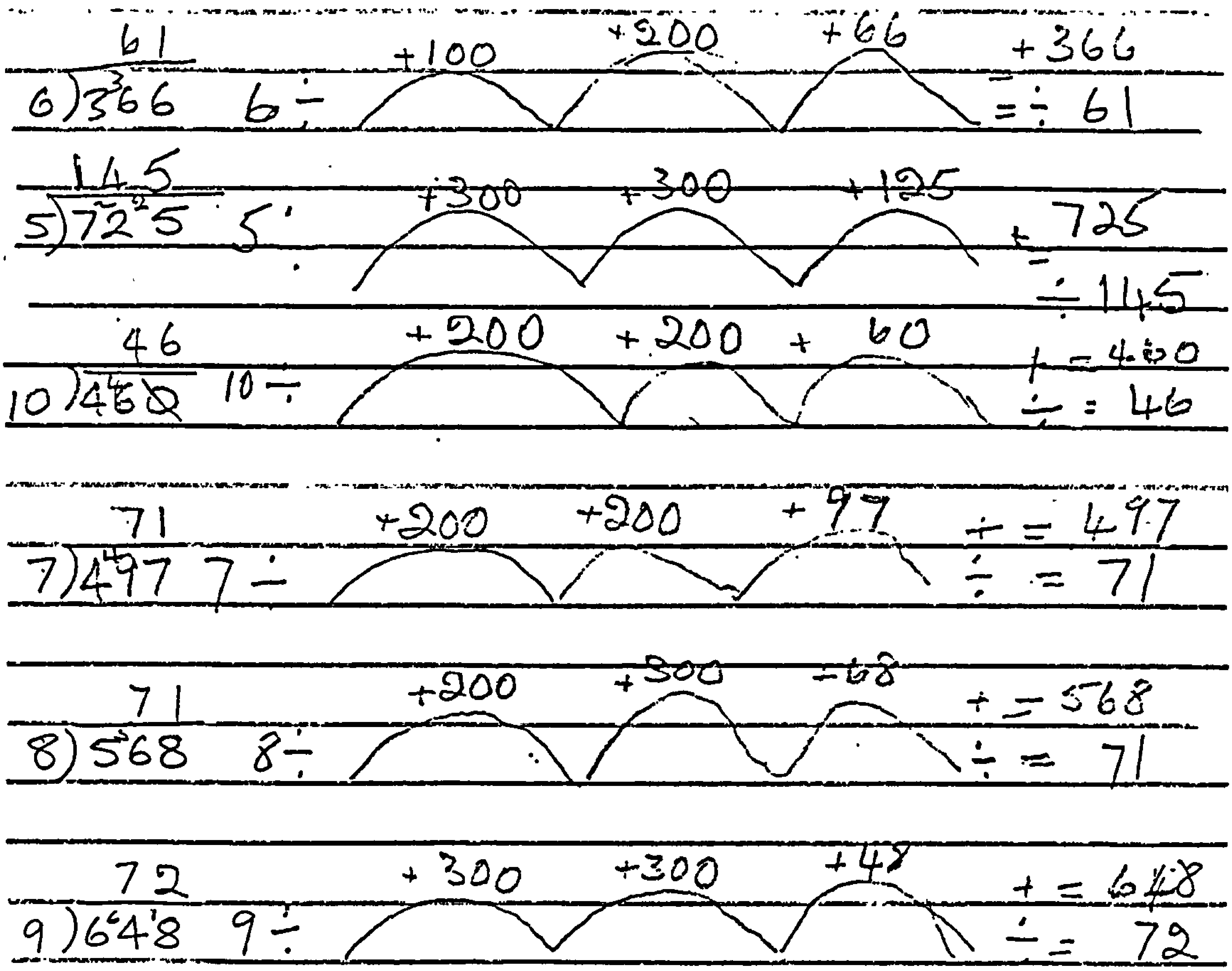
Tracy wrote,

> *A very easy and quick way of doing sums. It's easy seeing how you do it in your mind. At least this way you don't forget.*

3.2 Sandra

Sandra's sheet shows her using the ENL to work on division. The 'standard' layout on the left was written by me, after Sandra had attempted to use the number lines.





Though the numbers are clearly laid out in a line, Sandra used the printed lines on her writing paper rather than drawing in lines. She worked down the page like this. She then said she wanted reminding of 'how you do it' usually. I wrote out the problems, using the usual algorithm layout, on the left hand side, leaving the answers blank.

Sandra then found the answers, using this standard algorithm, and copied them to the right hand side (e.g. = ÷ *14*). The number lines, then, seem to have been used to show the size of a number by breaking it up: 56, for instance, is 20+20+16. One possible way to use this would be to divide each component by 4, so the solution would be 5+5+4= 14, and this is an approach used by many people when solving division problems mentally. However, Sandra broke 568 into 200 + 300 + 68, which is not so clearly helpful for division by 8. It's not clear to me how this strategy would consistently help with dividing, but Sandra's comment was:

> *Relate to what you're doing, find a picture of sum easier. Find I can count better. I was able to do sum very quickly.*

4 Summary and themes

Here I summarise the themes to be taken forward to Chapter 11.

4.1 Discourse and the detail of number work

One finding from these two pieces of work is that far more is going on, and may be important to the student, than we can tell from a written piece of work. What may seem trivial details make a difference to the ability to tackle a subtraction sum, and a number line that looked useless (for this purpose) to me helped Sandra with division. Clearly the minutiae of both verbal and visual routines are central to at least some people's solution of number problems.

It seems that something that looks *totally* different from the student's existing algorithm is not necessarily off-putting; perhaps it is less liable to 'interference' from an existing method. Thus Jenny, who said of decomposition, 'Oh, I'm not listening, it's confusing me', tried out an ancient Egyptian method for long multiplication (she was not impressed by it, but did not find it interfered with her existing method). The value of an algorithm lies in it's routine, patterned quality, both visually and verbally (and quite possibly kinaesthetically - in the movement of the pencil); it is a *whole*, such that changes in one step may throw the solver off track.

In comparing Sandra's 'How do you do maths?' with the ENL work we are dealing with different elements of discourse - algorithms, patter, mental operations, written representations. None of the students whose work is discussed here 'needed' to use a written subtraction algorithm in order to get to the answer; they would all be able to find a solution mentally. The question 'How do you do maths?', combined possibly with Sandra's writing of the problem in columns, triggered responses in terms of standard algorithms. Meanwhile, much more open questions in the ENL work, with no set problems to solve and an invitation to critique the approach, produced creative explorations of numbers.

'Context' in calculation is more generally used in discussions of the overall context of the mathematics work (e.g. Evans, 2000b; Lave, 1988; Schliemann, 1998). Yet here it seems that *within* the abstracted, routinised discourse of the standard algorithms, details as apparently trivial as the placing of a subtraction sign may affect students' ability to reach successfully the end of the routine, and this is despite extraordinary similarities, to the outside viewer/audience, in layout and patter.

Implications for pedagogy

I would argue that this work both shows mathematics strategies to be embedded in discourse, and shows the poverty of our tools for discourse analysis at this level. The notion of discourse is useful in placing all communication in the context of power relations (so, for example, Sandra's asking of a question may generate different responses from a tutor's question); in showing how speech and writing are tied to each other in their context (the written algorithms and the patter); and more generally in seeing representation (words, numerals, number lines, gesture or graphic layout) as a generator of meaning, rather than an added-on way to present some essential, external, immutable meaning (Gee, 1999; Kress & van Leeuwen, 1996). I would suggest two directions for further work. As teachers and students we can engage in further discussion about the detail of work in mathematics, in terms of both individuals' routines and the fact that such routines are very powerful.

Firstly, we could work more closely towards understanding the minutiae of students' practices: by watching and listening more carefully to students' work; by asking students whether we are writing and explaining sums clearly; by asking them to point out differences between their and our methods; and so on. Students' understandings of the meanings of calculations differ from each other's and from tutors'; we need to work more on unpacking these meanings.

The power of an established method means that students may find exploration of each others' algorithms 'confusing'; on the other hand, though I have quoted one student saying she would not listen, others did not apparently have such difficulties. My second suggestion is that opening up a discussion about *why* it is confusing may be fruitful. Such a discussion might be expected to raise issues like these:

- What makes something 'maths'? (For example, is the ENL as much 'maths' as a standard algorithm?)

- What makes a method the 'right' one? Does the answer to this question lie in the problem (a method which suits the numbers), with the solver (a method in which s/he is confident), or some mix of the two?
- What triggers set us off using one method rather than another?
- What should we do if a method works but doesn't aid understanding, or vice versa?

The point is not to come to clear-cut answers to these questions but that such a discussion may help students and tutor to explore both their own experiences and views of maths and the discourse of the maths classroom.

Although Sandra's initial question *How do you do maths?* assumed, and got, fixed answers, in a later article she wrote (in the third person):

> *Sandra decided to do some research of her own. She put a light on the sums, and questioned why do we have to do it this way? (Wilson & Tomlin, 1999)*

So the process of research led her to question the fixed world of the algorithm; her comment demonstrates her engagement, through the research, in the kinds of questions listed above. Such a discussion at a 'meta' level is consistent with the suggestion in this thesis that unpacking the discourse of the maths education classroom with students is a productive endeavour (Chapter 11).

4.2 'Meaningless' maths?

Both the algorithms and the ENL work show students working on 'empty' calculations: there is no problem to be solved beyond representing and manoeuvring your way round numbers. This does not mean that the work is unrelated to 'practical' maths, since if students found methods that were helpful they could be used in other contexts (and Tracy carried on using the ENL for subtraction and addition, as well as traditional algorithms). But I don't think applicability to 'real world' problems was uppermost in anyone's mind. In Chapter 11 I challenge the distinction in dominant and critical maths education discourses between 'real world' and 'meaningless' maths; for now, I suggest that apparently 'meaningless' maths engaged students in analysing and exploring the discursive practices involved in calculating.

4.3 Student researchers in the classroom

This chapter has illustrated the shifts in my own methodology resulting from students' work as co-researchers (discussed further in Chapter 11). It would not have been written had a student not proposed it to me. The work has opened up detailed discussion of the closed world of the algorithm; and inviting students to try out methods from other research similarly broadens our view of how students may be thinking about numbers.

> *Sandra got enjoyment learning from other students that there are different ways, and doing the research, and thus became more confident. (Wilson & Tomlin, 1999)*

Chapter 8: Students writing maths questions

Students asking questions and setting agendas is a theme throughout this thesis, ranging from research and interview questions to the details of classroom interaction. This section describes and analyses a range of mathematical questions posed by students. Although there has been considerable research into projects and investigational work in which school students pose their own mathematical questions (Morgan, 1998), far less has been written about students' posing their own problems for practice of mathematical skills. Chapters 6 & 7 focused on an investigation and on some calculation methods; here I discuss 'word problems' intended to provide opportunities for the application and rote practice of particular mathematics skills, with some work by students which is less easily categorised. I will use the terms commonly used by students: 'sums' are mathematical tasks and calculations presented as figures, with few or no words, and may involve any operation (not only addition); 'problems' are presented in the form of words. I first survey some of the issues around word problems, and then consider six groups of questions posed by students (with students' solutions in some cases). I then reconsider issues raised in the first section in the light of the students' work.

1 Word problems

Word problems represent an attempt to place mathematical skills in a context which purports to come from the 'real' world. They seem to have existed ever since formal maths teaching and learning started. In England, Robert Recorde published word problems in 1543 (Howson, 1995); their history goes back at least to ancient Egypt and Babylon. This is a Babylonian problem:

> *A cistern was 10 GAR square, 10 GAR deep. I emptied out its water; with its water how much field did I irrigate to a depth of 1 su-si? (Fauvel & Gray, 1987: 27)*

Fauvel and Gray comment,

> *The situation described ... is strongly idealized in that the water is required to be spread to a uniform depth of one finger's breadth over a field which is approximately 3 $^1/_2$ kilometers square. (ibid.)*

This idealisation is the kernel of many critiques of word problems. To be accessible to the student, at a given level of mathematical education, and to provide practice in the application of a particular skill, problems have to be controlled both in the complexity of the numbers (or measures) involved and in the number and type of operations required:

> *[A]ttempts to put mathematics in context are more often motivated by the justified and educationally desirable goal of helping students develop the skill to model a particular (frequently contrived) situation in mathematical terms (and, usually, using the mathematical techniques currently being acquired) than to exhibit*

> *societal problems, the solution of which can be expedited, or even made possible, by mathematical means. (Howson, 1995: 59)*

Hugh Burkhardt distinguishes between

> situations *by which we mean problems arising* outside *mathematics in whose understanding a variety of mathematical tools may be used, and* illustrations *which are chosen concisely to illuminate a particular mathematical point by displaying it in a concrete setting... Illustrations are 'clean' with neat, right answers, whereas situations usually start out with messy, not very well-defined questions. (Burkhardt, 1981: 5-6)*

Almost all the word problems met by ABE students are 'illustrations'. Such questions in the context of school maths tests are critiqued by Barry Cooper and Mairead Dunne, whose research showed that working-class children were more likely to respond in 'inappropriately' realistic ways. They question what is being assessed:

> *Is it primarily children's 'mathematical' knowledge and understanding* per se, *or is it primarily their capacity to negotiate the boundary between the 'mathematical' and the 'real' as part of the process of discovering the test designers' intentions for the item? (Cooper & Dunne, 2000: 200)*

Negotiating that boundary is one of the central concerns of this chapter.

Typical word problems ('illustrations') are not questions to which the student 'needs' an answer. The necessary simplification may seem to divorce the problem from its supposed context. Hence Marcelo Borba writes

> *A problem can be authentic or it can be imposed. An imposed obstacle or puzzle would be a pseudo-problem, a situation which occurs frequently in mathematics teaching. Students are usually asked to solve problems which are not problems for them personally; they only attempt to solve these pseudo-problems in order to get a good grade. (Borba, 1997: 264)*

Word problems are often a source of anxiety and anger for students. Recent research with adult mathematics students in the US (Curry et al., 1996) identified word problems as a past and present source of frustration; in school they are 'the hated word problems' (Thomas & Gerofsky, 1997). Verschaffel, Greer, & De Corte (2000) survey research into the 'suspension of sense-making' induced by word problems.

There is an additional issue in basic education classes. Many of the students have difficulty with reading, and may share the common difficulty in understanding 'what the question is asking' (that is, what sum to do), but also have difficulty in technical decoding of the question; when the genre is unfamiliar, reading makes more demands on technical decoding skills (Curry et al., 1996).

The Basic Skills Agency initial student assessment test includes 'problem-solving questions':

> *People need to be able to function at the problem-solving level because calculation almost always has a purpose. To calculate effectively you need to:*

> - *think about the situation or, perhaps, read about it*
> - *decide on which calculations are needed to solve the problem*
> - *do the calculations.*
>
> *Some people fail to complete problem-solving questions successfully because they have not thought about the problem or decided which calculations are needed to solve it. Just being able to do the calculations is often not good enough. (Basic Skills Agency, 1997: 4)*

The BSA here ignores

- any difficulty about the assumption that word problems test ability in 'real world' problem solving
- the emotional weight carried by word problems (particularly important given that this is a time-limited test)
- difficulties with reading (in the sense of technically decoding text) and writing.

These three issues are addressed throughout this chapter, and at the end I shall return to them.

One response to the alienation and frustration produced by 'pseudo-problems' has been to propose the application of maths in contexts which have more meaning for the students (Masingila & Prus-Wisniowska, 1996; Noddings, 1993; Verschaffel et al., 2000). Munir Fasheh argues that simplification of problems renders them meaningless:

> *The difficulty in mathematics (as well as in other subjects) stems from the fact that we artificially simplify concepts, and usually in such a way where they lose their meaning to children. Taking ideas and concepts out of their real (and usually complex) contexts does not make them more comprehensible ...; if anything, it usually makes them less comprehensible. (Fasheh, 1993: 18)*

He advocates asking questions 'from the world':

> *An extremely crucial tool in meaningful and invigorating teaching is the type of questions we ask or encourage our students to ask. Such questions usually stem from the world rather than from textbooks. The kind of questions we ask in classrooms or on tests [...], or allow children to ask, is one of the biggest obstacles to learning. (Fasheh, 1993: 18-19)*

I would agree with the spirit of his proposals. There remains the practical difficulty that many 'world' problems are intractable at the student's (and often the tutor's) level of mathematics. I will illustrate this with a 'real world' problem brought into the classroom.

Margaret's electricity bill

When I asked a group of students to 'bring in some problem to do with maths', Margaret asked the group about her electricity bill. She was moving; she had the choice of a quarterly-read meter (with further choices of payment method, some of which reduced the unit price), pre-paid plastic card (requiring a deposit) or cash meter. She had a low weekly cash income, and wanted to know both which was the cheapest payment method, and which would be easiest to handle. Within the discourse of maths education, working out an answer would require checking the unit rates, standing charges and deposits for all payment methods; if relevant (a question in itself) checking Margaret's previous average bills; estimating her likely consumption in the new flat; applying answers from the first questions to Margaret's probable future consumption; and comparing results. This is technically demanding, even with a calculator; for example, unit charges are expressed in pence to two decimal places.

Margaret understood perfectly well that the maths involved was 'too difficult' for her - that was exactly why she brought the problem to the class. It was solved, but not by mathematical methods, or at least, not following the steps outlined above. Others in the group advised her that the card would suit her best. Their reasons included flexibility (you can charge the card up as much or as little as you want) and security (if it is stolen it can be replaced; a cash meter is a temptation to burglars; paying a quarterly bill involves carrying cash and risking loss). I said I thought a quarterly bill, paid by direct debit, would be cheaper. They agreed, but all, including Margaret, ruled it out because they could not take the risk of direct debits on small and fluctuating bank accounts.

Margaret had done what Fasheh proposes: she brought in a mathematical problem 'stemming from the world'. Its solution came from students' knowledge of what works, in social as well as economic terms: the group's 'fund of knowledge' (Moll & Greenberg, 1992). Perhaps going through the problem mathematically, following the steps I outlined above, would have given the class useful practice in mathematical modelling (Burkhardt, 1981) and calculations; on the other hand, precisely because it was a real problem, we did not have time (Margaret was moving in a week).

Marcelo Borba and Ole Skovsmose argue that word problems in a school context introduce students to the 'dangerous' belief - contributing to an 'ideology of certainty' - that real-world applications of mathematics are similar to the questions and difficulties they face when dealing with word problems. They use 'the landscape of discussion' as a metaphor for the terrain of word problems:

> *1. An* 'Empty and rocky landscape' *contains mathematical objects only;*
> 2. The cultivated landscape *makes up a pre-structured reality. Mathematics can be applied to a variety of problems... A mainstream of post-structuralism has invited students to travel around in such organised landscapes ...*
> 3. The Amazonian jungle *represents the chaotic and unorganised landscape for discussion... We think of the broader thematic approaches as well as many forms of project-based mathematics education as examples of students trying to find their way through such a jungle. (Borba & Skovsmose, 1997: 21)*

They propose voting theory as an example of project-based mathematics. I would argue that such a topic is more likely to be proposed by a tutor than a student; hence though the landscape may appear jungle-like to the student, the tutor stands far enough above it to be able to see its limits and possibilities. Margaret's electricity bill problem, on the other hand, would have been a trip into the jungle for the tutor as well as the students.

Word problems are, then, a bone of contention for both students and researchers. They are intended to provide opportunities to apply and develop skills in a comparatively realistic context. They are criticised exactly because the contexts are *not* realistic; yet genuinely real-world problems may be insoluble at the students', or the tutor's, 'level'.

2 Maths questions by students

My initial interest in the idea of students' writing their own maths questions had three main sources: literacy practice (Chapter 2), numeracy practice and a key text by Marilyn Frankenstein (1989). In literacy work, I had been asking students to ask each other questions about their writing, and I had found that this approach helped the readers (as well as the writers) to read more critically, and allowed students to do some of the questioning usually left to teachers; in doing so, it changed both the final texts and classroom discourse (Tomlin, 1998). Meanwhile the *Take Away Times* (Colwell, 1988), a free A3 numeracy broadsheet published by ILEA, included students' writing, sometimes not specifically 'about' maths, with related mathematical questions, and work through the NFVLS (National Federation of Voluntary Literacy Schemes, later NFVES) raised questions about the limited kinds of maths offered to basic education students, and similarly gave examples of questions posed by students (NFVLS, 1986). Finally, Frankenstein (1989) asked her readers to write their own 'review quizzes'. Frankenstein's text, via my own re-write, has directly shaped some of the questions to be discussed here, including some published in *Global Maths* (Chapter 10 and Appendix 10); this intertextuality (Fairclough, 1989) will be discussed below.

The student-posed questions to be discussed here open up ways to reconsider the three interrelated issues raised above: the application of mathematics skills in specific contexts; difficulties with reading and writing; and students' affective responses to word problems. The questions are grouped as follows:

1. a word problem by Tanya
2. fractions problems in *Global Maths*, drawing on Frankenstein, by Lorraine, Marguerite, Tanya and Sandra
3. word problems by Sandra

4. word problems by Sue and Sandra, using a 'kit' for problem composition
5. word problems in *Global Maths* by Leroy and Owen
6. questions by Sue and Sandra, looking at a photograph of a block of flats.

In the course of the research project, many students wrote or dictated problems and sums; these are only a selection, chosen to illustrate the range. They start with those that most closely match the textbook word problem genre. In most cases my discussion will be informed by students' comments on the experience of writing and/or solving the problems.

The word problem genre is analysed by Susan Gerofsky (1996), and I shall use her terms in this discussion (for debate of her analysis, see Gerofsky, 1999; Thomas & Gerofsky, 1997; Toom, 1999):

> *Most word problems, whether from ancient or modern sources, and including "student-generated" word problems, follow a three-component compositional structure:*
> *1) a "set-up" component, establishing the characters and location of the putative story. (This component is often not essential to the solution of the problems itself.) [The set-up is] simply an alibi, the only nod toward "story" in the story problem. It sets up a situation for a group of characters, places and objects that is generally irrelevant to the writing and solving of the arithmetic or algebraic problem imbedded in later components.*

The other two components are:

> *2) An "information" component, which gives the information needed to solve the problem (and sometimes extraneous information as a decoy for the unwary).*
> *3) A question. (Gerofsky, 1996: 37)*

2.1 A word problem by Tanya

Tanya wrote this problem as a contribution to her group's work on the general topic of money:

> *There are 12 people waiting to use the phone. Each person spends 28p a minute and 3 minutes and 45 seconds on each call.*
> *a) how much does each call cost?*
> *b) how much do all the calls cost?*
> *c) how long does caller number 9 have to wait before it's his turn to use the phone?*
> *d) how long does caller number 11 have to wait?*

She has caught the genre exactly: set-up, information, and four questions, in a suitable order (that is, one in which earlier problems are imagined to be easier than later ones).

This problem stands as an excellent illustration of a pseudo-problem (Borba, op. cit.). Using a public telephone box may well be part of Tanya's real life; this question however removes all the uncertainty and unevenness of a telephone queue and replaces it with an abstraction. (In my own experience, the relevant money problem would not be the total cost, but whether the telephone took cash or cards, and whether I had the right coins; and as one of the students said, caller 11 would be long gone ...) It was difficult, for Tanya as well as others. No-one knew how to handle 45 seconds on a calculator, and some tried 3.45 x 28p to find the cost of one call, rather than 3.75 x 28p. Most assumed caller number 9 had to wait 9 x 3 mins 45 seconds, rather than 8 x 3 min 45 sec.

The group worked together on the problem for more than 20 minutes. I had the impression that Tanya's fellow students wanted her to feel she had done well in writing the problem, and so committed themselves to solving it; at the same time, the risk of 'failure' was removed, since no-one (initially) knew the answers. The fact that it was written by a student, and at that by a student who could not herself immediately answer the problem, transformed the discourse of the classroom. The value of this work does seem to lie in the 'application of maths skills in a range of contexts'. However, here the relevant context the students are coming to understand is not a telephone queue but the genre of maths word problems.

2.2 Fractions problems in Global *Maths*

drawing on Frankenstein (1989), *by Lorraine, Marguerite, Sandra and Tanya.*

These four students came from three different groups yet produced strikingly similar fractions problems, written after the students had worked on a fractions pack I had adapted from Frankenstein (1989). Frankenstein invites readers to write their own 'quizzes', and gives examples of 'error patterns' - supposed solutions to problems, by a 'solver' who has some misconception about the problems. In basic structure Frankenstein's fractions problems generally fit the Gerofsky model. Her 'set-up' elements are often drawn from contemporary US social and economic data (Frankenstein follows the 'critical mathematics' model discussed in Chapter 2), and the 'information' element is often a diagram. I rewrote Frankenstein's chapter on fractions for a British readership, changing the problems so that they reflect British contexts, shortening and line-breaking the text and enlarging the print, but generally copying the original diagrams. I kept the suggestion that students write their own quizzes (two, of five questions each), hence these fractions problems, later published in *Global Maths.* Appendix 8 gives an extract from my own text.

The similarities across the student-written fractions problems show the students learning very quickly and efficiently how to write in a specific genre - Frankensteinian fractions problems.

The fractions problems in *Global Maths* (Sandra, *Global Maths* pp. 12-14; Lorraine, p. 35; Tanya, p. 36; and Marguerite, p. 48) reflect Frankenstein's approaches, from the basic notion that students should write their own problems, to some of the phrasing and the shapes used to illustrate fractions. For example, one of Sandra's problems is identical to one of Lorraine's. They are both a direct quote from my text, which is in turn a direct quote from Frankenstein:

> *Name the fraction which represents the circled part of the diagram.*

The only difference is in the size of the fraction, and the diagram: Lorraine's has a regular array of dots, with a wobbly outline drawn round some, while Sandra's has an irregular group of dots, with a circle drawn round some (*Global Maths*: 35, 12). These students had never met; their common ground is in the text provided by their teacher, and their work shares intertextual features. Intertextuality (Fairclough, 1992b; Morgan, 1998; Wallace, 1992) is not an 'approach' to writing, or a 'process' of writing; it is an inevitable reflection of the impact and influence of previous texts on the writer. Fairclough (1992) defines it as the property of being full of 'snatches' of other texts, whether they are 'explicitly demarcated' or merged (p. 84). Here while some questions have 'snatches' others use Frankenstein, via my re-write, as a template.

Less obvious 'snatches' from Frankenstein are embedded in these two questions by Sandra (*Global Maths:* 12-13):

> *Out of 489 Scotland Football team (in 1990) only 6 were from the north. What fraction of the teams are from the north.*
>
> *According to the Southwark County, one in six employers discriminates against black job applicants. Write that as a fraction.*

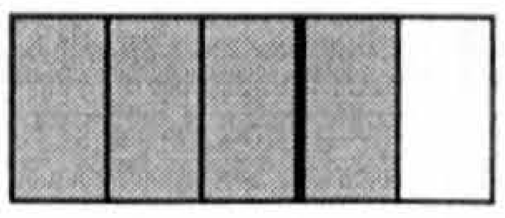
When I amended Frankenstein, I replaced her contexts with British ones. Thus one of my questions related to the number of women judges as compared to the number of men; another was

> *According to the Runnymede Trust, one in three employers discriminates against black job applicants. Write that as a fraction.*

Sandra was brought up in Inverness and lives and works in Southwark. She used my text exactly as I had used Frankenstein: kept the question and tweaked at the 'set-up' to make it relevant. The only difference is that I had checked my figures, whereas she made them up; this suggests that maths students assume all problems are made up, since their purpose is (usually) to practise a skill rather than provide or question information. All the writers of fractions questions similarly use Frankenstein's basic structures.

Frankenstein presents error patterns for analysis, and this was incorporated into some of the students' work. For example, Tanya wrote,

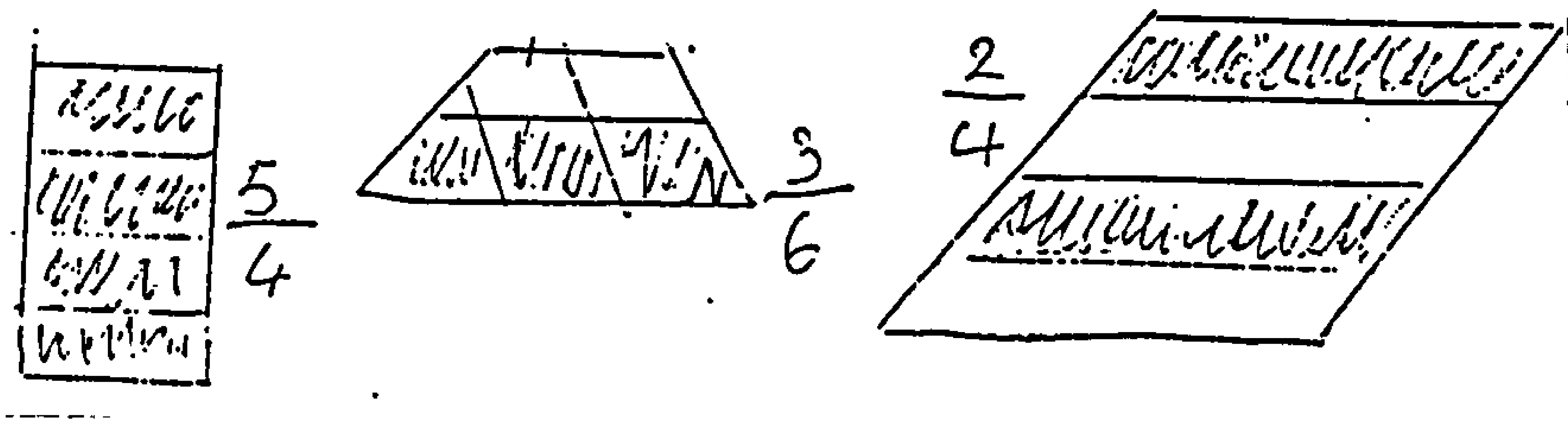
> *Q3 Where did I go wrong on each fraction? Read below.*



I was asked to shade 4/4 of a fraction. (Global Maths: 36)

However, there are some apparently accidental errors. This is another of Tanya's problems:

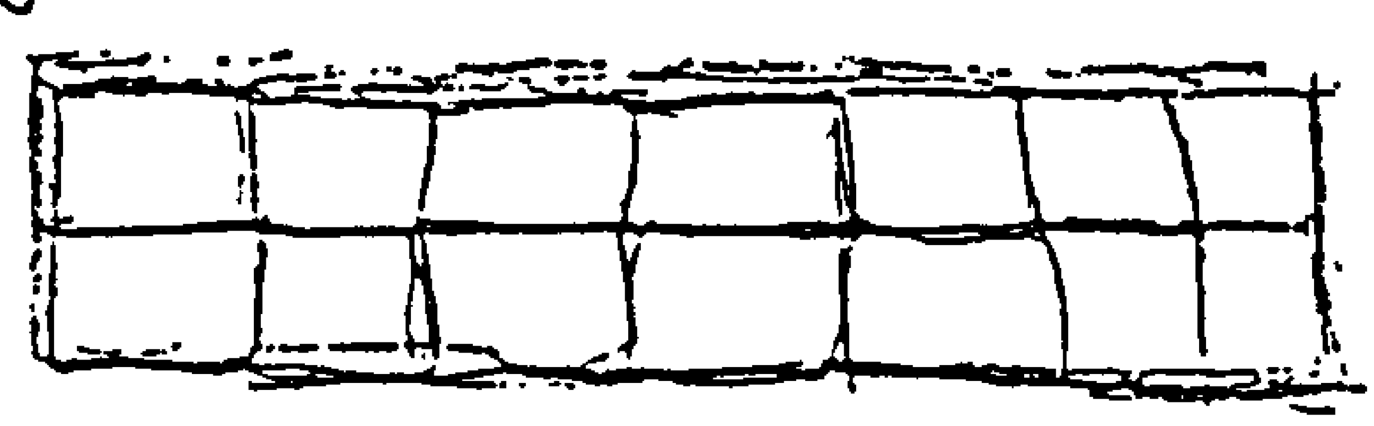
Q.5 Name each right fraction.



It is not clear whether the '3/6' diagram is a deliberate error or not. Three out of six pieces are shaded, but Frankenstein's examples included errors based on not knowing the pieces have to be the same size. One student suggested the 3/6 design showed a flat tile held at an angle from the viewer and drawn in perspective. Some who thought 3/6 was ok were challenged by others: 'it doesn't look like half, though.'

Marguerite wrote this question:

4 children have a bar of chocolate between, how will you divide it.



This was much harder than anything her group had come across in their work on the Frankenstein-based fractions pack. Marguerite had intended there to be twelve pieces of chocolate. The students decided to ignore the fact that the chocolate pieces are different sizes, and assume they were all the same. Answers proposed included 14/4 each, 3 each and 2 left over, mother eats two pieces before dividing the bar, $3\frac{1}{2}$ each and $3\frac{1}{2}$ / 14 each. These solutions led to discussion about how they could all be right (you have to specify whether you are talking in terms of pieces or bars of chocolate). No-one gave up.

These fractions problems, and particularly those which were ambiguous or difficult, sustained the interest and commitment of both the writers and their colleagues as they worked on solving them. The 'set-up' components seemed irrelevant, at least for purposes of solving the problems: for example, no-one but me checked whether Sandra's statement about Scottish football teams was true, and no-one really imagined that someone dividing a chocolate bar will fret about fractions. The set-up components do, however, work to make the student-written problems 'realistic', in the sense of fitting the genre.

Fractions are both one of the most feared and hated topics in maths and a common request, presumably because people want to recover from past experiences of failure; we have seen also that word problems in any maths area commonly cause panic. Yet much of the work on solving fractions problems written by students was cheerful, challenging, argumentative and creative. I suggest there are three reasons for this. As with other student-written problems, students are prepared to commit themselves to solving problems written by their peers. Secondly, hand-drawn, inexact diagrams lend themselves to ambiguity and hence debate. (This may be a parallel to work on a photograph of a block of flats, discussed below.) Thirdly, the hand-written and photocopied presentation of the problems is not associated with the authority of the textbook or teacher's worksheet and is therefore less unnerving.

2.3 Word problems by Sandra

Some of Sandra's fractions questions have been discussed above. Here I want to consider in more detail both Sandra's writing processes and the benefits she gained from the work. She has particular difficulties in writing, arising from childhood experiences and continuing poor health.

Sandra wrote two review quizzes, the first with ten questions (twice the suggested length) and the second with five (*Global Maths*: 12-14). I shall discuss, based on an interview, her writing processes for the two sets of questions, what she gained from writing questions, and then the use we made of the tape transcript itself in *Global Maths*.

2.3.1 Writing the first ten questions

Sandra *Right. You asked me to do (.) or the worksheet asked me, to write five questions. So what I did, I didn't think to think up myself, at first kick off. So I says right, I'll look at the first question, and then sort of make up one from there, but copying one, the same thing. So I tried, and I tried, and I tried. And all I could get out of that was frustration... I got so muddled up I was giving myself a headache in the end. And as I was going along it was just making it far too hard for myself. You know I had to keep coming away, and I says there's got to be an easier way to do this! And when I went (.) I got the idea. I remembered the print and what I seen on that first page had been written, then I come over to this page. Everything went out of my head (.)*

Alison *So you (.) I just want to say for the tape recording, you're doing gestures with your hands. You've got your left hand saying this page, and that's the [re-written] Marilyn Frankenstein, is it?*

Sandra *Yes*

Alison *and when I came over to this side, which is your right hand side, that's your writing, yeah?*
Sandra *To write down my idea, had gone out. So I was getting more and more frustrated, trying to do it. So the rubber was getting good use. I keep rubbing out all the time, and it was very hard going. So I did the ten questions, but they were not easy.*

When writing this first group of questions, she used the (re-written) Frankenstein as a mini-dictionary; for the second set of questions she asked her husband for spellings instead. However, she also sought to use Frankenstein as a model of the range of questions included in the genre:

Sandra *... the reason why I tried to do that, looked at the booklet, is so my spelling wouldn't be caught out. That's the only reason that I did that, and to keep in mind the rhythm that you wanted some of the questions brought out. Not in the order, but ...*
Alison *How do you mean rhythm? Say more (.)*
Sandra *Like, it could be some a problem one, or some a circle, that sort of thing, and that's what I was looking for.*

This is a description of a student finding the model text, or scaffolding, getting in the way of expression of her own ideas. The 'frustration', 'muddle', 'hard going' and 'headache' (physical as well as metaphorical) of writing these questions are hidden in Sandra's finished texts. As I listened to Sandra's description of her writing processes, I felt guilty that I had asked her to go through so much trouble and I commented on the invisibility of the writing process:

Alison *You see they [your questions] look so, um, confident (.) I mean to me reading them they (.) they don't (.) look as though they took that much sweat, they look like (.) I'd say, Oh, she knows what she's doing here. You know? You look as though you're really on top of it.*
Sandra *Well if you were (.) if my husband was to come through that door, and you asked him the same thing, he says it took Sandra all day ...*

Reading a student's text, then, may mislead us into falsely thinking the student is confident (in the mathematics concepts, the writing, or both). Although the student's questions may often form valuable learning materials for other students, we need also to consider what the process of the writing can tell us (student and tutor) about students' understanding of the mathematics concepts and the maths problem genre. A reading of her text would suggest that Sandra had been able to immerse herself in, and reproduce, the genre; the interview suggests quite the opposite.

2.3.2 Writing the next five questions

Sandra wrote another five questions (*Global Maths:* 14) in response to reading a further section of the Frankenstein-based text. What she had learned from her earlier experience was that she should *avoid* using the Frankenstein model:

> *I sat down, and I says right, I'm not going to fall into the same trap. [laughing] ...I'll make up five other questions, oh, this is - this is a piece of cake! So I sat down. I says right. In the class, we're doing fractions. I'd better stick to the rule. So that, that's my first thought. So, I sat down, and I thought, the easy bit didn't come easy! [Both laughing.] Not for the first one. So I had to wait awhile, and after a while, my husband says 'Sandra, are you getting stuck?' He says, 'Go and look in your book' [the re-written Frankenstein]. I says 'No! I'm not opening that book'. I says 'It spoils my concentration. I shall get me all frustrated.' I says there's no way I'm going to do that way. So eventually, I did the first one, and once I got the first one out, there was no stopping me.*

I asked Sandra what 'sticking to the rule' meant:

Sandra *It's that [the re-write of Frankenstein] (.) not look at a printed (.) letters ..*
Alison *Right*
Sandra *in a book, or like the sheets that you give us out, because I know they make me frustrated reading them (.) I see problems, I sweat, I panic. So I knew I wasn't going to do that to myself. Just sit there, and write down calm, calm.*
Alison *So your rule is kind of do it for yourself from your [head*
Sandra *[head, and try and be as calm as possible. ... There are problems that I do have,' and I know it, but I will keep fighting them.*

So 'the rule' was Sandra's rule, not the model text; 'sticking to the rule' meant *abandoning* the scaffolding. As tutors we could reasonably assume a model text would support students and therefore help dissipate the sweat and panic, but for Sandra the model text was the source of the problem, not a contribution to a solution. *I wasn't going to do that to myself*: she wasn't going to inflict on herself the damaging effects of a printed text.

The first two questions of this second set were particularly difficult both to write and to solve, and will be discussed below. They have nothing to do with the supposed topic, fractions. The last three are about fractions:

> *3) Do these fractions and fill in the missing numbers*
> *a) 1/4 = __/20 .... [etc]*
> *4) Reduce the fractions to their lowest terms*
> *a) 3/9 = ... [etc]*
> *5. I have 2/3 bag of ready-mix cement left and I am given 1/2 bag by my neighbour. How much do I have altogether.*

Having rejected using Frankenstein as a model, because reading threw her off her own ideas, she was able to write standard fractions questions (3 and 4). These two are not 'problems' to Sandra, unlike her question 5. A 'problem' is defined by its having words:

Sandra *It's just that I says well, I'm going to put some numbers down [the first questions, discussed below], and then I'll go back to the fractions, which, you see I did, mid-way. And then because I know also, which is in the foreground of my mind, it's a problem, it's there....*
Alison *The problem for you, with dyslexia you mean, [or the problems with words?*
Sandra *[No no no, a problem, a problem. Like the last question today was 'a problem', on the fifth question.*

Alison *Right. So how did you make that up? It was a great question.*
Sandra *I just thought of an apple, as in divide that apple into so many pieces. [Laughing]*
Alison *How did you think up that cement bag one, the cement mix?*
Sandra *Well it may not make sense to you, but I just was thinking of an apple, and I was cutting the apple up in different pieces, and there was something on TV about cement, so I just put the cement in. [Laughing.]*

Question 5 matches exactly the Gerofsky model of word problems; evidently that is also Sandra's model of 'problem'. She describes replacing one 'set-up' (an apple) with another (ready-mix cement). The apple probably came from a recollected discourse of school maths; by replacing it with something heard on TV (an intertextual snatch) Sandra shows she knows how arbitrary a set-up can be.

2.3.3 What are the gains for Sandra from writing questions?

The panic and sweat are not around fear of lacking skills in mathematics, but the discursive framing of the maths. Indeed, the questions Sandra wrote were deliberately challenging at her own level of mathematics. At the time of the interview Sandra's group had just together worked through her second group of questions. She had said she found the first two difficult:

> *1. Put these numbers in order of size with the smallest first.*
> *a) 305 b) 35 c) 350 d) 530 e) 503 f) 53*
> *2. Put these numbers in order of size with the largest first.*
> *a) 51 b) 15 c) 510 d) 150 e) 105 f) 501*

Both depend on numbers with two or three digits, including zero, and varying the order of the digits. In writing these questions Sandra did not know the answers. Zeros are particularly difficult for her to 'see'.

> *Yes, I'm not good at the first two questions, and I (.) I knew the block there, because of the dyslexia, I knew the block was there, but I keep pushing myself at that (.) so I can (.) not give in. 'Sandra, because you've got that problem, you can't do these things'. I just keep pushing against it. So one day, like tomorrow, I'll be able to do it, sort of thing.*

She had volunteered her questions as group work, although she had not had an audience in mind as she wrote them:

Sandra *No, I wasn't thinking of the group, or you [laughs] when I was writing them down, and I don't work them out or anything like that. And then coming to the class, everyone was getting the answers, and I said [inaudible] there must be something wrong with me. And I'm still away at the first, and somebody's at the third, or the end.*
Alison *So you're finding other people doing them quicker than you?*
Sandra *Yeah, much quicker. I'm behind.*

I suggested she was 'behind' because she had put the questions that she personally found difficult at the top, and she agreed:

> *Get them over and done with. I thought it would catch some people out, including myself, which it did, one of them did.*

Having written them herself didn't prevent Sandra measuring her work against others'. However, she did not 'panic' or 'sweat' (when in difficulties with word problems she sometimes had to leave the room; there was no sign of such a crisis).

Gains, then, from writing her own questions include having questions which are challenging in exactly the area in which she wanted to develop her skills, and feeling sufficiently in control to be able to maintain focus.

Although I asked Sandra whether she had improved her understanding of the mathematical concepts through writing questions, she spoke more about a general sense of pride in herself at the achievement of writing the questions:

> *Yeah, though I say that the questions were hard to write them down, and thinking them up, and that sort of thing, and then when I stopped and put everything away, then looked at them, I said, Eh, Sandra, you are pretty clever. So I do enjoy it in a way. [...] When the class have finished with my questions, and answered them, including myself, I said Sandra, good after all your hard work yesterday, good!*

She felt differently about the first set of questions:

> *It's a no-go area. It's just a case of getting it all down, and forget about it.*

Sandra's pride in her work may then be linked to the group's validation through their work on the questions. Setting maths questions is usually within the teacher's role; by both writing questions and leading the group in attempting them, Sandra was shifting the discourse of the group.

2.3.4 Using the tape transcript

The interview with Sandra surprised me. I had made false assumptions from reading the first set of questions: that writing the questions helped her get inside the fractions problems genre, and that she had found it helpful to have Frankenstein as a guide. I think those *are* potential benefits to students; however, the interview demonstrated the complexity of Sandra's, and therefore possibly others', experiences of and responses to maths texts. With Sandra's approval and editorial control, I wrote *Writing maths questions* (*Global Maths*: 15-16), based on the interview transcript.

It outlines the main issues raised above: attempting to use another text as a model; frustration, sweat and panic; writing the second set of questions, including mathematically difficult ones; overcoming spelling difficulties; and pride in her achievement. The aim was to illustrate for other students that there is no single standard way to achieve the writing, and panic can be recognised and if necessary acted on.

Using the tape transcript in this way serves other purposes too. It values a student's work, both in the writing of questions and in the research; it presents a student as an experienced writer, by implication with knowledge that may help others; it recognises individuality rather than speaking from a tutor's necessarily generalising position; and it speaks from inside a world in which spelling and reading may be serious difficulties. It thus further disrupts dominant mathematics education discourses.

When describing to new students how they too can change, Sandra often says, *You can write your own questions.* She says the panic has not gone; however, she can manage it.

2.4 Word problems by Sue and Sandra, using a 'kit' for problem composition

2.4.1 A long multiplication kit

Some students are able to use the textbook word problem as a template, inserting contexts and numbers into the appropriate blank spaces in the 'three component structure' (Gerofsky, 1996: 37), and we have seen examples of problems written by students which successfully fit the genre. For others, writing their own word problems is not straightforward. Two students, working together, wanted more practice in long multiplication problems (and had finished the available practice worksheets). I suggested they write their own problems. They wrote sums, but no word problems, and asked me again to produce more worksheets for them, because they 'couldn't think' what to write, and 'they [the problems] won't be right'. The word problem genre is part of the wider discourse of mathematics education, and the students were uncomfortable with a shift in roles whereby their entry to that discourse might be threatened (for example, if the problems they wrote did not closely model those in the examination). (They may have been concerned too about standard spelling.) For these students I wrote the following 'kit':

> ***A Do-It-Yourself Kit for long multiplication problems***
>
> Many people worry more about word problems than plain sums.
> One way to make them easier is to ***write your own problems.***
> This sheet is a kit for writing typical multiplication problems.
> Move along the columns from left to right
> picking words and numbers you fancy,
> and put them together into problems.
>
> For example ...
> *I buy 35 lbs of potatoes @ 12p. Total cost ...*
> *Albert, Pauline, Joy and Christine have a holiday, costing £340 each. What is the total cost?*
>
> Of course, you can also make up your own problems.

I buy	20	settees	@ 52p	What is the total cost?
John buys	32	second hand cars	costing £23 each.	How much does he pay?
Arianna wants	12	pounds of potatoes	at 12p.	What is the bill?
Samson organises a day out, for	35	pensioners	at £2300 each.	What does it cost?
A shopkeeper buys	27	pairs of trousers	at £340 each	What should she pay?
A railways clerk sells	42	tickets	at £19.99.	What is the total?
Albert, Pauline Joy, Christine, have a holiday.			@ 63p	How much do they pay?
The five-a-side competition is entered by	221	metres of ribbon		How many players are there?
I want	13	tickets	costing £5 each.	What will it cost?
I buy	85	young people	at £62 each.	What does it cost?
We take a group out on a trip. There are ...	15	pounds of sweet potatoes	at £1.75 each.	How much is it altogether?
The community centre sells	145	teams	£425 each	Total sales ...
The day centres provides lunches for	12	people	It costs £15 each.	Find the total takings.

The kit gives Gerofsky's 'set-up' component in columns one and three, 'information' component in columns two and four (though two of the 'set-ups' include 'information' in column one), and the 'question' in column five. I explained that you choose from the columns, working left to right, and showed how the two examples were made up. It was intended to offer both realistic problems (where 'realistic' means not 'taken from students' experience' but closely fitting the word problem genre) and the opportunity for parody (I suggested as an example 'Samson organises a day out for 145 pensioners at £2300 each. How much does he pay?'), but all the students who have since used the kit have produced only realistic (true to genre) problems. This suggests that the 'set-up' element must have some plausible relation to real life in order for a problem to be regarded as fitting the genre, and/or that students don't feel sufficiently confident to be able to parody it.

The two for whom I wrote the kit did not write out the problems they composed, but only the 'sums'. The kit answered their demand for tutor-set work, and evidently worked to expose the artificiality of the contexts, such that the numbers could be immediately abstracted from the 'problems'.

I then gave the kit to Sue and Sandra, and will now discuss the problems they wrote.

2.4.2 Sue's kit questions

The day centre provides lunches for
85 pensioners costing £5.00 each.
What is the total cost?

85 The total cost is £425.00.
2 5
425

A railways clerk sells 20 tickets at
£19.99. How much is it altogether?

19.99 19 99
x 20 x 20 Altogether it is £399.80.
389 80 399 8 0

John buys 12 pairs of trousers costing
£23.00 each
How much does he pay?

23 John pays £276.00 for his
x 12 trousers
46
230
276

Every word and number of the problems Sue wrote came from the kit. Her work shows her calculations, and the solutions are written into sentences each of which re-orders the wording of the question (so 'How much is it altogether?' becomes the answer 'Altogether it is £399.80').

When Sue joined the course, she wrote in her maths history,

> *At written problems I have trouble with how to do it, and it is panic time coming up.*

After she had written and solved these problems, I asked her what she thought of the kit, and she dictated this comment:

> *It's useful going down it. It helps with when you first do it, writing your own problems, and you're not sure what you're doing. The second one [problem] I did, I wasn't sure about the line up, so I did it to give myself practice.*
> *[So are do-it-yourself problems better?]*
> *Mix it, do-it-yourself and teachers' problems.*

Her response suggests that she expects to write her own problems in future and sees the kit as a starting point - exactly my object in designing it, but not one I had mentioned to her. However, she also addresses the issue of computational practice. Her second problem requires multiplication by a multiple of 10. Many students solve such problems by applying the standard long multiplication algorithm and thus including a redundant row of zeros:

```
 19.99
 x  20
 -----
  0000
 39980
 -----
399.80
```

I think this was the issue Sue was addressing in the 'line up' (decimal numbers appear only in this problem, but she has no difficulty with them). Like Sandra, she chose to write something challenging at her level of maths. For Sue, then, the 'wordiness' of writing problems does not preclude seeing through them to the required calculations. Writing her own problems caused her no panic or anxiety, and the kit led both to her successful writing of problems which closely mirror those she would meet in her exam, and a view of herself as someone developing as a more independent problem-writer.

2.4.3 Sandra's kit questions

Sandra had already written word problems, and had identified them as a particular source of panic. Her kit-based problems are less closely tied to the kit text than Sue's, despite Sandra having more difficulty with spelling.

(1) I buy two settees for £19.99 each
The total price is £39.98

```
  19.99
   x2
 £39.98
```

(2) Samson organyses a weakend away for 20 pensloners which it would cost £23 each for the weekend
The total price is £460

```
  23
 x20
  00
  46
 £460
```

(3) The community centre sells 145 tickets to a group of young people of 15. How much money do they collect.

$$\begin{array}{r} 145 \\ \times 15 \\ \hline 725 \\ 145 \\ \hline 21.75 \end{array}$$

Money they collect is £21·75p

(4) A man sells 12 secondhand cars at £425 How much profit does he make.

$$\begin{array}{r} 425 \\ \times 12 \\ \hline 51.00 \end{array}$$

The man profit is £51-00

(5) I buy 42 metres of pink ribbon for two people. How much will it cost

$$\begin{array}{r} 42 \\ \times 2 \\ \hline 84 \end{array}$$

First I will compare her questions to the kit text. The underlined words do not appear in the kit:

	Sandra's question	*Comments*
1.	I buy <u>two</u> settees <u>for</u> £19.99 each. <u>The total price</u> is £39.98.	*Two* is Sandra's choice; at the time of writing these problems she was being rehoused and seeking cheap furniture. There is no question, but an answer to an implied question.
2.	Samson organises a <u>weekend away</u> for 20 pensioners <u>which it would cost</u> £23 each <u>for the weekend.</u> <u>The total price</u> is £460.	The kit suggests *day out.* Adapted from *costing £23 each* in the kit. Answer to an implied question.
3.	The community centre sells 145 tickets <u>to a group of</u> young people <u>of</u> 15. How much <u>money do they collect</u>. <u>Money they collect is</u> £21.75p	The syntax of the kit suggests 'young people' could be used without Sandra's introductory 'a group of' ; the suggested information to go with 'tickets' would come from column 4, but Sandra's question uses two figures, 145 and 15, both from column two. Neither is apparently a price in the kit, though for Sandra's solution to work the 15 must be 15p. Sandra's wording suggests the *age* of the young people is 15, though she treats it as a ticket price. (See also

		comment on question 4.)
4.	A man sells 12 second hand cars at £425. How much profit does he make. The man's profit is £51.00.	The kit questions appropriate for sales are *Total sales, Find the total takings, How much is it altogether?* and *What is the total?* (the last two could also be used for prices). If *profit* means surplus over costs, then Sandra's question is unanswerable since she has not specified the cost of the cars to the dealer. However, *profit* fits the discourse of second hand car dealing. Sandra's insertion of a decimal point is an error (recognised when I asked her to re-read the question). This may suggest that in question 3 the decimal point was inserted out of habit, thus making sense of the problem.
5.	I buy 42pmetres of pink ribbon for two people. How much will it cost.	No space between *42p* and *metres*; it looks as though Sandra wrote 42 metres, then inserted the *p*. Slight variation from *What will it cost* and *How much is it altogether*, available in the kit. The 'set-up' of this question is confused. Sandra resolved that by ignoring the set-up, in effect, and multiplying the two figures together (her solution is 84). As in question 3, Sandra here used two figures from column 2 and none from column 4.

I asked Sandra what she thought of using the kit. She had already written some word problems herself, without using the kit, and seemed to see the kit as something closer to tackling word problems written by others:

> *It's better doing it that way [using the kit] than the written problem with just words. They freak you out! I don't want to know when it's like that.*

I have already noted that panic at word problems is well recognised. Sandra identifies the 'set-up' of the problems as the source of their emotional impact:

> *Every one was real. Certain words, like tickets and ribbon (you'll never believe me), certain words I like, that's why I went for them. I like the sound of them, that's why I went for them, there's something you like, so you want to look at that question. Like if that said two hospital porters, I wouldn't want to look at that question whatever it was about.*

This suggests that the set-up of a problem can tilt the student's reading of the text into a different discourse (in Sandra's case, hospital porters would be a trigger for the discourse of hospital and illness) and is consistent with Evans' argument that

> *the inter-relationships of thought and feeling ... are important in that, because of the inevitable tendency of language to flow in unexpected ways and generally to assume multiple meanings, they may put the intended transfer [of mathematics learning between school and outside contexts] at risk. (Evans, 1998)*

Similarly, Gerofsky writes,

> *the nature of the stories attached to the algebraic problems is relevant to students in terms of affect and in terms of the student's willingness to try to solve the problem at all. (Gerofsky, 1996: 38)*

2.4.4 The kit and classroom discourse

Both Sue and Sandra wrote problems which could be approached without use of the standard algorithm. Both selected £19.99p as a price; it could be rounded to £20 to make calculations easier. I suggested both students would have done this had we been doing discussion-based work, or if the problems had been in the real world. Using the kit thus became a vehicle for discussion of whether the word problems genre leads students to particular, 'standard' solutions which may not be the most efficient.

Using the kit enabled both Sue and Sandra to solve word problems without the panic they often experience. Sue identified the kit as a starting point on a road to writing her own problems independently (though she would also want to work on teacher-set problems); Sandra compared using the kit to answering textbook questions. The kit could then be seen as leading in either direction. Like the two students who immediately translated their kit-based problems into sums, Sandra and Sue 'see through' the word problems to the sums; despite Sandra's questions not exactly fitting the genre she produced sums out of them, revealing, I would argue, a good understanding of the artificiality of the genre and the purposes of word problems. Students' writing their own problems can also support assessment of the students' skills, since it may reveal instances in which students don't know how to apply mathematical operations. The kit offered a vehicle for students and tutors to discuss Evans' 'tendency of language to flow in unexpected ways'.

2.5 Word problems in *Global Maths* by Leroy and Owen

Leroy and Owen both wrote word problems on the theme of money, their group's chosen topic for that term; the problems were then included in *Global Maths*. Writing the 'problems' (as I shall discuss, they do not all closely fit the 'word problem' genre) revealed issues in the articulation of different discourses and voices, including maths education and the word problem genre, students' knowledge as skilled workers (Masingila, Davidenko, & Prus-Wisniowska, 1996), the discourse of property ownership and the tutor's conflicting interests.

2.5.1 Owen's problem

Owen's problem includes all Gerofsky's components: the set-up (painting a room), the information and the question ('Find out the cost ...'):

Find out the cost for painting a room, 8 foot by 12 foot.

The ceiling, skirting board and windows	*Two gallons of paint*
The walls	*Two gallons of paint*

One gallon of wall paint would cost about £15.
One gallon of ceiling paint would cost about £20.
Two brushes - about £3.50p for the pair.
A rolling brush - about £2.50p.
A paint tray £1.50.
White spirit, 1/2 litre £1.50.

Owen reads slowly and with some difficulty, and this problem was originally dictated to me. As I typed it, I amended it because I could not myself make sense of the quantities of paint; the words I changed are underlined above.

In the first draft, 'wall paint' (emulsion) was bought in litres and the 'ceiling' paint (gloss) in gallons. On re-reading this, it seemed Owen would buy more gloss than emulsion; even allowing for his choice of gloss for the ceiling this seemed wrong to me, and I altered the 'litres' to 'gallons'.

When I explained my alterations to Owen and asked if I was right, he said I was but looked doubtful, and I remain unconvinced. Too late I considered the problem that he is a painter and decorator by trade and I am not. In retrospect I think I had in mind the combination of three 'facts': litres are smaller than gallons (true); you buy less gloss ('you' means me; this is probably not true for Owen, and may not be true for 'you', the reader of *Global Maths*); and gloss costs much more than emulsion (but I have never bought either in these quantities, and have no idea of trade prices). My 'facts' about painting are dubious, then. It may be that in this case the tutor's knowledge over-rode the student's, so that what looks like a student-written problem is tutor-written. One of Owen's aims in maths is metric measurement; he would be unlikely to argue with the tutor about it.

Although Owen's problem does fit the Gerofsky model, the 'information' reveals Owen's real-world knowledge. The prices given are all rounded - in some cases overtly so ('about £3.50p for the pair'), and in some cases simply given ('White spirit, 1/2 litre £1.50'). This is highly unusual in the word problem genre, where if estimations were used it would be part of the student's task to produce them. Some students in working on the problem asked Owen what he meant by 'about' a sum of money; it was not clear to them whether they had to insert an exact figure (say, £3.48p) or work with Owen's.

2.5.2 Leroy's problems

1. Tiling a bathroom.
The bathroom is 8 foot by 10 foot.

The tiles are 4" by 4".
35p each.

2. Rent £76 per week.
Find the total for twelve months.

3. Mortgage £114 per month.
What is the yearly total?

Leroy's three money problems were more straightforward in terms of apparently fitting the word problem genre. However, the group when working on the problems decided the first had inadequate set-up and information elements. (It also has no question element, though all assumed the question was implicit: the cost of the tiling.) The group spent about an hour working together on the problem; their work included discussion of how to find the area of the walls ('8 foot by 10 foot' misled some into thinking of 80 square feet; they had to decide on the height of the tiling) and estimating the area of wall taken by the door, bath, washbasin and toilet, in order to be able to subtract that from the overall area to be tiled. They debated and decided to ignore the space taken by grouting, against the advice of the two decorators in the group who argued that in a room of this size that would lead to unnecessary wastage. The group was able to shift between the real world (measuring the classroom door to use as the measurement of the bathroom door) and the arbitrary discourse of word problems ('no, no bathroom cabinet'). I would argue that their commitment to the solution of the problem, which was not a 'real' problem for any of the group members, came from their commitment to each other and was founded in the problem being written by a group member.

2.5.3 Leroy's house insurance

Global Maths had another item by Leroy, which arose from telling the story of his house insurance to the group. He was passionate about this. The building society had been, he argued, exploiting him as a home-owner because he didn't understand how insurance premiums were calculated. He described to the group how he went to the building society, argued his case, got a leaflet from them on how they calculate premiums, and then did the measuring and calculating himself. He described measuring the first downstairs room, with the intention of measuring every room and then totalling the areas, and then two great realisations: firstly, you could measure round the outside of the house, which is quicker; secondly, you could then 'just double', because the first floor would be the same as the ground floor. He won his case and got a reduction in his premium. I asked him if he could write the story for the magazine, for which the deadline was in three days; he said he could not, because he didn't have the figures with him.

I tried to persuade Leroy that the figures didn't matter. In my hearing of the story, it had two main points, firstly that you should not trust building societies, and secondly a description of how to measure a house, including short cuts. It both used mathematics skills to challenge a building society on its own territory, and showed the practical application of mathematics skills to the student's benefit; more generally, the story showed a student moving from perceived ignorance (in the building society's view) to appropriate knowledge. It came from the 'real world' (Fasheh) and challenged the 'ideology of certainty' (Borba and Skovsmose).

Leroy was determined to include the figures. It may be he thought the story would carry less weight without them, or in some way would be less true; or the figures were the point (rather than the politics). In the event he brought this writing to the centre the following day:

TIPE of Property Semidetached
Area: Ground floor 26 SQ.Ft. X
21 SQ.Ft = 546
First floor 546 SQ.FT.
546 + 546 = 1092 SQ FT
Average Rebuilding cost
Per SQ.FT. £54 X 1092 = £58 768
Shed, Patio, Fences Extra
£1032 Total Rebuilding cost
£60.000 Total Sum to Be
insured £60.000

Three Bed Semi

When I received this writing I decided to edit it. Leroy had provided, in effect, the answer to an unstated problem: how his insurance premium should be calculated. Because part of the 'set-up', in Gerofsky's terms, and the question were omitted, Leroy's writing did not fit the word problem genre. However, it also did not fit other genres I imagined would be appropriate for the magazine (for example, a diary entry, an autobiographical account, or a moral tale). So I wrote the opening lines, and Leroy later approved them.

This is the article as it appeared in *Global Maths*:

House Insurance L. Dingwall

Leroy disputed the cost of his house insurance
when he found he was paying more than his neighbours.
He found the premiums are based on the rebuilding costs.
He had to measure the rooms,
but then he found he could measure round the outside,
rather than do each room separately.
These are the figures Leroy worked out.

Three bed semi

Type of property	Semi-detached
Area	
Ground floor	26 ft x 21 ft = 546 sq. ft.
First floor	546 sq. ft.
	546 + 546 = 1092 sq. ft.
Average rebuilding cost per sq. ft.	£54 x 1092 = £58 968.
Shed, patio, fences	Extra £1032.
Total rebuilding cost	£60 000
Total sum to be insured	£60 000.

I put Leroy's name as author; on the other hand, I didn't feel I could write Leroy's story in the first person, since that would suggest the wording, as well as the story, was his, and would be based on an unfounded assumption of intimacy between us. We ended up with an odd amalgam with the author mentioned in the third person in the text. My impression is that Leroy was quite satisfied with this text. I hankered after either more politics and drama, as in the oral version, or some more explicit mathematical content, particularly something about the 'just double' (hidden in 'First floor 546 sq. ft') and the 'extra £1032' which handily makes up the sub total of £58 968 to the final total of £60000 and probably represents a calculated decision to go for neatness rather than accuracy.

Whose is the 'voice'? Fairclough uses the term 'voice' to 'focus on the subject positions of particular genres or discourses' (Fairclough, 1995: 213 n. 3). This text is heteroglossic, defined as

> *double-voiced, since it interleaves two different* whos-doing-whats *together.... [or] two (or more)* whos-doing-whats *more fully integrated, and harder to tease apart. (Gee, 1999: 25)*

Here we have a mix of three voices: the Building Society leaflet, a maths word problem and literacy education reading material (my own introduction). Leroy's oral story fitted perhaps a fourth category, something like 'politically pointed anecdote', but that has survived only in my word, 'disputed'.

Leroy was happy with the version that went into print, and rejected the idea of writing the story as he had told it. He made a choice to use the language of the building society in his account of his victory. It may well be that one of the things he learned and wanted to use from the episode was the discourse of the building society.

2.5.4 Leroy's and Owen's problems, and classroom discourse

Leroy's and Owen's work shows up the gap between students' expert, real-world knowledge and the tutor's submersion in the academic discourse of maths. Neither Leroy nor Owen wrote about existing real problems (the closest to that was the House Insurance article, which demonstrated how an answer had been found). Nevertheless, their writing builds on their expertise and undermines a discourse in which the tutor is the sole expert. There are two relevant elements: the genres of the maths learning materials, and mathematical knowledge, and both were challenged by Leroy and Owen's work.

Unlike, for example, Tanya's telephone queue problem, I have argued that Owen's and Leroy's problems did not exactly fit the word problem genre; further, the 'unfit' parts are those which generated the most discussion. So students were able to apply their own mathematical understandings and choices, or ask the experts among the group.

The problems (including the house insurance oral account) led to considerable discussion and work on calculation and measurement. Students' commitment to the work was generated I think both because of the interruption to the discourse, so that the problems were far less closed and invited more debate, and because the problems were written (and the house insurance solved) by their colleagues. Problems were read aloud several times as students worked out their approaches, thus helping those who have more difficulty with reading.

We should note that forms of writing which are not immediately identifiable as 'appropriate' in the discourse of maths education may be uncomfortable for the tutor. I wanted the magazine to include a story that was obviously generalisable to others' experience, and so for me the building society figures were unnecessary. I had heard a story that indicated underlying ways in which maths is used in this society and had a clear political point; I wanted something I judged would make good reading; certainly I thought if I didn't 'get the story off Leroy' that day it would be lost. The word problem format is so standardised that it limits our acceptance of new forms. These new forms of problems generated debate both about the mathematical solutions and about the discourse of maths education; divergences from the standard word problem genre led both the student group and the tutor to recognise the variety of genres at play in a given mathematical story.

2.6 The block of flats: questions asked by Sue and Sandra

I got the idea of using an image without words or numbers as a resource for mathematics work from Netherlands adult education colleagues whom I met at a conference (Haacke, Duin, Leek, & Laat, 1998), and I discussed the photograph below (originally A4 size) with Sue and Sandra when they asked me what I had learned at a research conference. Although neither of them had tried such work before, they immediately generated a group of questions about the block of flats. In terms of Gerofsky's word problem model, the 'set-up' and 'information' components are embedded in the photograph, leaving the students to write the 'questions' only; they did so through dictation (the original questions were in my handwriting):

How many flats are there?
What is the height of the block?
What is the width of the block?
What is the area of the block?
Is it built on springs?
How many windows?
How many balconies?
How many people live there?
Family block or single people?
Where is it?
- city or out of town?

The following week the group worked on the questions; Sue had done them at home.

Most of the questions are clearly 'mathematical' in that the solutions would be expressed in numbers. One, *Is it built on springs?*, comes from civil engineering; we discussed why Sandra asked it, and learned that the high-rise block outside the classroom window was in fact sprung. The question *Where is it? - city or out of town?* also led to discussion; the students associated high-rise blocks with inner-city areas, but noticed the trees and low horizon in the poorly reproduced picture. The other questions all revolve around measurement and size. However, they also demand some knowledge of such buildings; the 'set-up' in the picture is inadequate. For instance, Sandra and Sue argued that each flat would have one balcony, not two; and there was some discussion about whether the wider balconies served two flats.

The group looked at Sue's answers:

How many flats are there?

16 x 4 = 64

There are 64 flats

What is the height?

The height is 11cm

What is the Width?

The Width is 5.5cm

What is the area of the block?

11 x 5.5 cm² = 60.5cm²

How many Balconies?

There are 64 balconies

How many Windows?

~~11 x 7 = 112~~ 64 x 7 = 448

There are ~~112~~ 448 Windows

There are 64 people living here.

It is a block for single people

The block of flats is in Manchester

Her conclusion that there are 64 flats was based on multiplying the number of storeys by the visible vertical lines of balconies (16 x 4 = 64), and she was immediately challenged by people arguing that the fourth, invisible side of the block would have another 16 x 2 flats. The height, width and area of the block are all based on ruler measurements of the twodimensional picture. Sue explained she knew well that the actual block would not be 11 cm high; she had been working on measurement and calculation of area and wanted to apply those new skills to the picture. I then raised the question of whether the 2D image was rectangular; no-one had noticed that it was not. Sue had decided there would be seven windows for each flat: kitchen (2), sitting room (2), bathroom/toilet (1) and bedroom (2); this was generally agreed. The group, from experience of council housing policies, argued it was unlikely that a block of that size would be for single people. As well as looking at the photograph, the group looked out of the classroom window at a similar block, and estimated, for example, the height of each storey, using closer objects (trees, people, the classroom) for comparison.

This wordless, numberless image led to creative, energetic mathematical work including calculation, measurement and estimation (of the image, people and classroom), ratio, and 3D spatial thinking. It built on students' knowledge of the real world while retaining ambiguity so that solutions could be challenged but not dismissed. Like most of the 'problems' discussed here, the questions are not 'real world' problems, in that no-one needed the answers; they were written solely for the maths class. The problems became 'real' because of the students' engagement with them; and the image itself is perhaps less abstract than the words and numbers of traditional word problems, both because it is an object that itself can be touched, measured, and so on, and because it became a representation of the real block outside the classroom.

3 Summary and themes

One of the central themes of this thesis is 'strengthening students' voice'. Using students' writing in the classroom seems self-evidently to do that, in using students' words as the focus of students' discussion. 'Voice' however has been problematised, in four ways:

1. the work is diverse - from precision-engineered 'classic' word problems like Tanya's telephone queue to 'Is it built on springs?' - so students' voices are not in unison;
2. critical discourse analysis, with its attention to the processes behind the text, has shown that a written text is not a clear window into the writer's mind. The evidence for whether writing questions is helpful must reside in more than just the written text;
3. the questions themselves are heteroglossic, carrying the voice of the writer but also the imprint of thousands of years of the word problem genre and of other influences - a building society, a TV programme, the tutor/scribe's input, the view from the window;

4. we should note too that none of the questions would have been written had I not proposed it, so the tutor's discourse underlies all of them.

So 'voice' is a complex construct. Here I draw together contributions from this chapter to three themes which run through the thesis: group work and using students' texts as learning resources; confidence in classroom discourse; and word problems and 'real life'. I then return to unsettling classroom discourse and strengthening students' voices.

3.1 Group work and using students' texts as learning resources

In common with most of the work by students discussed in this thesis, group work provided a supportive environment and was itself supported in part by the use of students' texts to start discussion.

All the problems discussed in this chapter were in some way generated through group work; most were also solved in a group context; and several led to challenging maths work in which a whole group was involved. In section 3.4 I discuss the unsettling of classroom discourse, for which group work is an underpinning organisational principle; here I focus on how the groups handled difficulties with reading and writing, vital if such work is not to further demoralise students.

Students may have difficulties with reading word problems. The difficulty remains with student-written problems - if not for the writer her/himself, for other students. The group context meant that the writer, tutor and other students often referred back to the text, reading it aloud and thus helping less confident readers. This was particularly so because the problems were often difficult for all the group, so discussion was useful to share ideas. Rather than a silent room in which individuals struggled alone to decode text, there was a shared discourse in which the written text was talked through, amended and argued over.

Writing their own problems is no simple task for many students, in terms of spelling as well as composition. All those whose work is discussed here have some difficulties with spelling (all take English or literacy courses as well as maths). We have seen that students' practices include using available texts as dictionaries - whether those are from the real world (the building society leaflet) or classroom learning materials. Students also used each other, the tutor and people outside the classroom.

A further strategy is for the student to dictate the problems to a tutor or another student. As with all 'language experience' work, we need to beware that the process can give considerable editorial control to the scribe (as we saw with my changes to Owen's dictated text). The work on a photograph of a block of flats shows a starting point with no written text, followed by shared dictation of questions. Sharing question-writing aloud may limit the scribe's editorial control.

3.2 Confidence and word problems

The evidence here supports the widespread recognition of word problems as a source of panic and anxiety. Students' fear of word problems is not, I argue, a fear of the maths itself but of its discursive framing: the fitful and ambiguous relationship of word problems to other discourses, and the authority relations in the classroom (both student-tutor and problem-solution). In Chapter 11 I argue that students' 'lack of confidence' is discursively constructed. One way to shift the discourse of maths classrooms is to promote collaborative group work, above; another is getting 'inside' the discourse of maths problems.

The context of a word problem - in Gerofsky's (1996) terms, the set-up - may tilt students into other discourse which they may feel unable to control (Sandra's 'hospital porters' example), or on the other hand can evoke contexts in which they are confident. Students' control of the contexts meant that they were able to do sustained and confident work, even on problems which proved difficult.

The development of maths skills gained through writing their own questions is not only the application of skills in the overt context of the set-up, but also the handling of the genre itself (except in cases where the word problem does not fit the genre so that students had to create part of the context). Students' questions, whether matching the genre or diverging from it, expose the structure of the standard word problem: for example, the set-up is artificial (so apples can be replaced with cement); and the word problem gives all the information needed (hence the shock when some student-written problems broke the rules).

My own discomfort with Leroy's building society story and Owen's quantities of paint suggests that the word problem genre is a key part of the dominant maths education discourse.

> *Discourses are about what can be said and thought, but also about who can speak, and with what authority ... Discourse is structured by assumptions within which any speaker must operate in order to be heard as meaningful. (Ball, 1990: 2-3)*

We have seen that in the case of Owen's painting problem I asserted my authority as tutor to change his text, and that I found it difficult to 'fit' Leroy's writing - or in Ball's terms, make it 'meaningful' - within the discourse. Written words (as opposed to numbers) appear in defined areas of maths education, including, in this research, investigations, mathematics history, students' mathematics histories, students' diaries and word problems. Texts which don't 'fit' disrupt the discourse.

Tutors always know, or can find, the answer to textbook problems. Students working on their own, or colleagues', problems were not so clearly positioned as more ignorant than the teacher. The generic word problem model makes the assumptions (among others)

> *that the word problem itself contains all the information needed to do this task, [and] that no information extraneous to the problem may be sought (apart from conventional mathematical operations which likely must be supplied). (Gerofsky, 1996: 39)*

Sometimes students' word problems did not meet these criteria. In these cases, the ambiguity of the criteria for solution leads to intellectual challenge and enjoyment. This suggests that some of the anxiety about word problems may arise from fear of incorrect interpretation of the problem (not knowing 'what to do'), and is removed when there is no single correct interpretation; the authority of the text, or teacher, is one source of the anxiety.

Further, the shift allows students to bring their outside knowledge into the classroom - so that, for example, Owen's and Leroy's expertise in tiling was recognised (though some problems, like Tanya's telephone queue, only nod to the outside world).

3.3 Word problems and 'real life'

One of the themes running through this thesis is the perceived gap between the 'real world' and both the maths classroom and academic maths itself. 'Hated word problems' (Thomas & Gerofsky, 1997) have become, over thousands of years, the archetypal way in which maths educators seek to bridge the maths classroom and the world outside. Most educators think the bridge should support two-way traffic, though that is disputed. While some argue for further investigation of outside- and inside-classroom maths practices with a view to closing the gap to be bridged (Masingila et al., 1996), others would see word problems as part of the colonisation of the world by dominant discourses of maths (the implication of positions taken by Walkerdine, 1997 and Dowling, 1998a).

A real world/classroom pairing suggests that the classroom is somehow 'unreal', and indeed I think classroom maths practices often lead us to simplify a real world problem to a point at which it has lost the messiness (Borba & Skovsmose, 1997; Burkhardt, 1981) that characterises many problems. This applies even to problems brought in from outside the classroom. For example, Lorraine describes her job like this:

> *I had 18 offices to clean in 3 hours, so I had to divide the time between each office ... [They] were on three different floors. (Global Maths: 23-4)*

A classroom discussion treating this as the 'word problem' genre could come up with 6 offices, or one floor, per hour, i.e. 10 minutes per office. The problem would be changed into one like Tanya's telephone queue: apparently realistic, but nonsensical. There are many unknowns - the sizes and furnishing of the offices, whether they are evenly distributed between floors, the time it takes to move cleaning equipment from floor to floor, for example; and probably some variables, such as whether all offices have to be cleaned to the same standard each day, whether office workers leave all the rooms in the same condition, and whether the cleaner has a break. The numbers tempt us to ignore the messiness; they suggest a tutor-written problem ('18 ... 3 ... divide'). This could then be another example of Evans' 'tendency of language to flow in unexpected ways'. Here, however, the direction of flow can be predicted, because it is driven by the dominance of classroom maths discourse.

The 'six offices per hour' solution is 'dangerous' because it could contribute to what Borba and Skovsmose (op. cit.) characterise as the 'ideology of certainty', that is, that real-world applications of maths are similar to dealing with word problems. So the office-cleaning example, in 'bridging' real and academic maths discourses, both exchanges a neat mathematical calculation for a real problem (the 'myth of reference', Dowling, 1998a: 6) and misrepresents real-world applications of maths.

That's not what happened when her group read Lorraine's maths history. The office-cleaning story was included in her maths history because her group saw it as mathematical. Instead of leaping to a calculation, they asked how she had solved her timing problems (trial and improvement over several days); they were supportive of how much experience she has of solving problems at work; and Lorraine responded by explaining her view of her maths needs. Along the way the group talked about what maths 'really is' - everyone was convinced that what Lorraine had done demanded maths skills, but no-one, including me, knew how to codify them in terms of maths.

We have seen in students' work on and about maths problems something much messier than a 'bridge'. Margaret's real problem was solved inside the classroom but not with exclusively mathematical knowledge. Tanya's archetypal word problem (the phone queue) out-does textbooks in its formality and idealisation, yet is probably triggered by a real problem (queuing for a phone). Problems which more closely reflected the outside world because the students had to decide what was essential information and then find it (tiling a bathroom) were simplified by the solvers in unrealistic ways (do without the grouting) but nevertheless used more 'real life' skills than just manipulating numbers (measuring the door). Working on the block of flats problems involved real (in the classroom) measurement, based on an assumption that it would apply to a real (outside the window) block of flats, as well as real measurement of a picture, ignoring its function as a representation of a real (Dutch) block of flats. A decision to replace apples with bags of concrete means the writer is using an abstract problem (addition of fractions) as a hook on which to hang supposed real objects.

Jean Lave writes that

> *Big messy word problems, in which the learner has a good deal of leeway to decide just what the problem is, give learners opportunities for 'mathematizing' experience in ways that 'everydaying' mathematics lessons cannot. (Lave, 1992: 86)*

Such problems allow learning practices from outside the classroom to surface in classroom practice; and 'forms of co-operative learning may well have this effect, given their improvisational and dilemma-driven character' (ibid.).

Lave's case is that we need to

> *move away from the relation that looms so important because of its theoretical and institutional history - that between the 'everyday', or 'concrete', and the 'theoretical', scholastic abstraction of school maths - towards a different distinction: that between things (real and imaginary) that do and do not engage learners' intentions and attention. (op.cit.: 88)*

The work reported reflects such a shift, and challenges the bridge metaphor.

We should also question the lowest common denominator of views of the uses of word problems: that they provide opportunities to apply mathematical skills at the level at which the student is working. Students seem to write, sometimes, problems that are 'too hard' for 'their level' but nevertheless find solutions to them. The student-written word problems often turned out to be mathematically challenging, as students either wrote questions designed to push at their own limits or wrote questions which were accidentally difficult. That suggests that much of the work we more usually do, with carefully chosen worksheets geared to exactly the individual's 'needs' (in the tutor's view), may work to hold them back; they may be barriers rather than scaffolds.

I have quoted above Borba, Skovsmose and Fasheh as theorists arguing for the use of 'real life' problems as maths education resources. I hope I have problematised this notion. 'Real life' problems demand actual solutions, where that is possible, and we have seen that the solution to Margaret's electricity problem came from others' experience, using mathematical knowledge but not exclusively so, and using no numbers. Further, to divide 'real life' from maths education may imply that maths education is not a real part of students' lived experience and is therefore in some sense trivial, despite the enormous emotional weight it carries. The dominant view of the classroom and 'real life' as separate domains will be further discussed in Chapter 11.

I support Gerofsky's conclusion that

> *it is important to think in new ways about the nature and purposes of word problems, about their inherent oddness and contradictions, and about our rationale for using them in school mathematics programs, rather than simply, unthinkingly visiting them upon future generations of schoolchildren. (Gerofsky, 1996: 43)*

Meanwhile we need to support students in their efforts to find ways to use them for effective learning, rather than seeing them as potential triggers for panic, anxiety and failure. Whatever the contradictions involved in word problems, they are probably here to stay. Students' 'authentic' (Borba, above) circumstances cannot be guaranteed to provide contexts for all the maths they may want; tutors and textbook authors will always attempt to offer plausible contexts for the development, practice and application of maths skills. I would argue that the work discussed here shows some approaches which have generated challenging mathematical work, used students' knowledge and improved their and their tutor's understanding of classroom mathematics discourse. Students writing their own problems may help them get 'inside' the dominant discourse, so that they may feel less alienated and more in control.

3.4 Unsettling classroom discourse; strengthening students' voices

I think the students' commitment to challenging maths work came from the unsettling of the word problem genre, in three ways. Firstly, something hand-written, by a colleague student, is less threatening than a textbook. Secondly, some of the questions were more mathematically challenging than students would usually be offered in a text chosen by a tutor as being at the 'appropriate' level; the challenge was sometimes accidental, sometimes deliberate, and sometimes because the question more closely fitted the 'real world' in not including all the 'set-up' information. And thirdly, students seemed to want to show the writer that her/his problems were productive and well-written.

Using students' texts as a focus for group work centres the group on students' rather than tutors' voices. We have seen that 'students' voice' is a complex notion; but in working on students' questions, groups were responding to their colleagues' agendas, not the tutor's.

Using students' questions both problematises the real world/classroom 'gap' and unsettles the discourse of the classroom, since the extraordinarily fixed structure of the word problem is one of the elements of classroom discourse.

Textbooks' and tutors' word problems may be intended to direct learners to

- develop mathematical insight (e.g. Thomas & Gerofsky, 1997)
- see connections between mathematical operations and the world outside
- practice particular algorithms
- find more satisfaction in maths (e.g. Masingila et al., 1996).

It is at least doubtful whether most word problems, in the contexts in which the students here had met them before, contribute to students' achievement of any of these aims. If anything it seems that for the students here, at least, their prior experience of word problems fits more closely with Walkerdine's suggestion that as people shift from sets of maths practices outside the classroom to those inside,

> *subjects from oppressed groups experience more keenly a disabling sense of fragmentation. (Walkerdine, 1997: 210)*

Yet in the 'unsettled' discourses in which the problems here were written and solved, the problems did support development in all four areas.

> *Some people feel that tackling new problem situations [as opposed to 'illustrations'] is research, which in a sense it is, and that it is unreasonable to expect any but the extremely able even to attempt it ... This is much too pessimistic. (Burkhardt, 1981: 24)*

Many of the student-written questions discussed here are 'new problem situations', and others intended as illustrations were much more 'messy' than expected. Burkhardt's comment is made in the context of developing modelling skills, not a central part of the questions discussed here. Nevertheless the work here shows some changes in classroom discourse which I shall argue (Chapter 11) arise from seeing students as researchers: in this case, discourse analysts. Their questions and solutions led to discourse analysis in the areas of genre analysis and negotiating the boundary between 'mathematical' and 'real' discourses (Cooper & Dunne, 2000: 200). The students are positioned as sharing agenda-setting, and using their knowledge rather than compensating for their ignorance. That discursive shift allowed students to develop and express complex mathematical ideas and defeat the panic and sweat usually induced by word problems.

Chapter 9: Meeting for Maths Students for Beginners

1 Introduction

This chapter discusses the *Meeting for Maths Students for Beginners*, a half-day conference attended by about 40 students, held in the summer of 1997 at Bede House in Southwark. The conference produced a mass of data on students' views of the curriculum, teaching approaches and tutor-student relationships; it also led to the publication of *Global Maths*, a magazine written and edited by mathematics students (Chapter 10; Appendix 10), and to students' further involvement in the writing up and dissemination of the research. The data discussed here includes my notes of the planning process, the students' and my notes of the conference itself and tape transcripts of the follow up discussions.

At the time I initiated the conference, analysis of the data I had gathered had suggested that 'writing' is inseparable from other forms of communication (reading, talking and gesture, for example), and I was developing an interest in wider discursive patterns. The data and analysis are intended to contribute to themes developed throughout this thesis including ways to unsettle traditional ABE discourses and strengthen students' 'voice', as well as themes relating to mathematics learning, teaching and curricula. The conference is an example of participant action research (Chapters 2 & 3), and I shall address questions about students' roles as researchers.

My idea that such a conference was possible arose from my background in literacy work (Chapter 2). In the voluntary sector in the later 1970s and 1980s a number of different organisations held a range of types of meetings for students and tutors/organisers, variously called writing events, conferences and workshops. Writing weekends for literacy students and tutors were organised through *Write First Time*, a national paper of reading materials written by and for students. The National Federation of Voluntary Literacy Schemes and the National Students' Association organised conferences and workshops (for example as reported in NFVLS, 1981); in general NFVLS events were mixed, and NSA events were student only. In the voluntary sector literacy scheme in which I worked in the late 70s and early 80s, students were active members of the management team and contributed to the planning and running of various events, including tutor training. When I told colleagues I was involved in organising a 'student conference', many expressed a kind of nostalgic delight, mixed with envy that I had time and support to engage in such work.

Three main sections follow. Section 2 gives the story of 'what happened'. In the third and fourth sections I discuss issues arising from the data. Section 3 addresses students' participation as co-researchers, and includes discussion of resulting changes in discourse patterns and of the meaning of PAR in this context; in section 4 I focus on students' views of maths teaching, learning and curricula. From these discussions I draw together, in the final section, themes which will be taken forward to Chapter 11.

2 The conference

This section describes how the conference was organised, including planning processes, the conference itself and follow-up discussions. It describes 'what happened', and gives contexts for the later discussion of data from the conference.

The Meeting for Maths Students for Beginners was at least unusual and possibly unique. My claim is that the active involvement of students in the organisation and management of the conference defined the discourse of the planning, the conference itself and all the resulting data, including the magazine. The conference was a success, on many levels, and I will describe its organisation in some detail, partly to enable the reader to have a feel of what 'student involvement' meant in this context, and partly to draw out implications for practice which may be useful elsewhere.

2.1 Planning meetings

I distributed a leaflet (Appendix 9) inviting people to take part in planning the conference to students I personally knew (about 30 people). Eight students completed and returned the slip. Of these, two (from the same group) did not in fact come to any planning meetings (after the second meeting, I stopped inviting them). One came from an LEA class in Brixton; the rest all came from Bede Education Centre, a voluntary project in north Southwark where I was the tutor on a course specifically set up to support my research. I fixed the time of the first meeting to suit those six people, Antoinette, Lorraine, Sandra, Shazia, Tracy and Violet; thereafter we fixed times during our meetings. My notes after the first meeting, attended by five of the six, summarised the make up of the group:

> *All women; four black, one white; all English speaking though one bilingual; two are mothers of young children; one has caring responsibilities for autistic nephew; one has disabilities (mobility, hearing, sight, dyslexia) and is partly responsible for care of very premature grandchild; one has adult daughter with severe learning difficulties and physical disabilities who lives with her. It is astonishing that these women should put themselves out like this - I don't know where they get the energy from.*

At the first planning meeting, one of the women brought along her boyfriend and he participated in the discussions (with the group's permission). Some time later, she told me she had been subject to sexual harassment and until the centre dealt with the man concerned, she wanted her boyfriend there for protection. Another of the organisers was recovering from a recent breakdown and had a death in the family during the planning period. None of the organisers dropped out, and we gained another two, Jeremy and Clare, both from Bede, who heard of the conference through students (they attended other classes). We had, therefore, eight student organisers, of whom I already knew six.

The first three planning meetings were held at Bede, in the common room, where the centre allowed smoking (the majority of the organisers were smokers), and in the small classroom; both were upstairs in a narrow and poky Victorian house. We had the benefit of support from Bede's workers, who were consistently helpful without getting in the way or making a meal of things. Courses at Bede include computing, and the student organisers were able to word process their own adverts and notes in the downstairs computing room. We had access to free photocopying and free use of Bede's other building, a community centre about 150 metres away. For the last meeting, we met there, the conference venue. Food was provided by the community centre's training cafe.

My leaflet inviting people to 'help organise a meeting for maths students to get together' by joining a 'conference planning group' (Appendix 9) stated my interest in writing within maths education. However, I needed to ensure that student organisers could 'own' the event and so I widened the potential conference agenda, including questions as wide as 'how could your maths classes be improved?' and 'what kind of maths do you enjoy?' I was much more directive about the tasks involved in organising a conference: 'We need to decide the venue, the date, what topics to discuss, how to organise the discussions, how to advertise the conference and probably much more'. This was the start of a continuing tension between trying to use my experience of organising similar conferences, and avoiding taking over.

I will describe the first meeting in some detail because it gives the flavour of the planning process. When I arrived for the first meeting, timed for 12 - 1 p.m. between classes, three people were already there, and we sat smoking in the common room; when the other two arrived (we had apologies from one) at 12.05 we stayed in the common room chatting, and didn't move to the classroom until 12.30 p.m. Violet had thought we were planning a series of events, rather than a one-off; when Sandra explained what we were doing (in much the terms I would have used), Shazia and Tracy looked at each other and laughed, evidently sharing a joke about a misapprehension. Either the leaflet inviting people to help plan the conference or my oral explanations of it were not clear. This contributes to evidence throughout the thesis that teacher-student communication is not transparent.

I had prepared sheets blown up to A3 with my agenda and space to record decisions. I thought a physically shared piece of paper might help us focus; it would be big enough for people to add ideas to the notes.

Throughout the planning, conference and follow-up meetings, most of us did not stick to written agendas, whether mine or the group's. I imagine that had I been more traditionally in charge of the planning, we would have gone through agendas in a fairly disciplined way. While still in the common room, much of my agenda was discussed, without any mention of it from me. For instance, the group decided on a half day conference, during school hours, after their own exams had finished; that decision took about five minutes. I raised the question of evening students who may be working during weekdays, but most of the planning group could not themselves manage a Saturday because of family commitments. They fixed on a Monday afternoon, the time the Bede students could all manage because their regular class was at that time. In effect, then, much of the timing (and therefore participation and, to some extent, content) of the conference was determined by the accidents of planning group membership. There is an argument that this process was anti-democratic; the small number of people there took a decision which excluded many people from the conference. But the conference would never include everybody, and this was the start of what I came to think of as the 'tutor shut up' approach to conference planning. Had I argued, I would have won because I had an incomparably stronger position (I am more experienced; I am a tutor; I controlled the money (section 3.4); it was my initiative).

When we moved to the classroom for the meeting proper I produced the agenda, starting with 'aims for the conference'. In fact there was a wide range of suggestions, from what I think is an 'aim for the conference', such as 'share ideas about maths', to topics for discussion at the conference (for example, 'what were we like before we came?'). These distinctions between aims, topics and organisation were apparently irrelevant to the group; they talked about 'the conference'. For example, the students' aims included 'get a good atmosphere with coffee and a chat so everyone knows everyone'. At the time this seemed to me an organisational issue; with hindsight, I now see student mutual support as one of my aims. There was little 'discussion' because the group agreed with every suggestion made.

Under that first agenda 'item' we agreed the date, time, venue, source of refreshments, transport arrangements, crèche workers and who would contact them, a list of educational centres to invite and who would contact them, how to organise small group discussions, how to get discussions in the small groups started and how to record the discussions. In about half an hour we had done nearly all the work needed; we finished before the 1 p.m.

official meeting end. My most pressing proposal was that I could try to type and distribute a collection of writing during the conference, if it seemed appropriate, and that was agreed, though in the end we didn't do it. There were two questions I raised which arose from my previous experience: how to get discussions in small groups started, and how to take notes or help participants write, given that many participants would have difficulty with writing. For the first, someone said 'Tell them bring some of the old work you have done'; for the second, several said the student organisers would help. I questioned that, since some have problems themselves with writing, and one of the students said, with some exasperation, 'You use a tape.' (Tapes are commonly used to record literacy students' speech, as part of language experience work. The use, and non-use, of written material throughout the organisation of the conference will be discussed below.) My note after the meeting said, 'I didn't say much (didn't have to) and managed to shut up and listen to what people said. This is like good community development work, I think - not education so much as community organisation'.

For the second meeting I again had a written agenda, which was more or less ignored. At the third meeting, several of the students (who had agreed to lead small group discussions) had begun to get anxious about how to keep discussions going. We wrote some questions together in the planning meeting, but by then I felt so little 'in charge' that I forgot them and left them behind. Before the conference Shazia wrote questions of her own (Some Questions to Guide You, below) and everybody used those instead. At the fourth and last planning meeting Tracy and Shazia distributed a summary of the conference plan called a 'memorandum' ('what's it called? you know? Yeah, a memorandum' - presumably a term learned in computing classes) which they had written for all the organisers to use (Appendix 9). We agreed on which rooms to use; my notes record, 'Agreed back hall for meeting - will be noisy, difficult etc but I think no-one else thinks that. Looks barn-like to me.' As the planning process continued, I was more and more relaxed, and by the time I reached the conference I didn't feel in charge. I wanted it to go well, but I didn't feel it was solely my responsibility if it flopped.

The process of writing the advertisement for the conference illustrates these shifting responsibilities. At the first planning meeting Shazia and Tracy started discussing ideas for a draft conference advert, but forgot to do it, so it wasn't ready for the group to discuss at the second meeting. A few days later Shazia phoned up to tell me it was in the post, and to ask me to give her my opinion of it. She was clearly very pleased with her work. When I read it, I was delighted she had produced it, but dismayed by some aspects of the content (I return to this in section 3.3.1). A comparison with my initial call to plan the conference shows what I thought were the advert's faults. It has minor spelling and grammatical errors, but my concerns were more with its readability, given that some of its probable readers were literacy students: the print was too small; it was not line-broken; sentences were too long; it was unnecessarily long and wordy. There was a further problem (discussed in section 3.3): it claimed the group had done work in maths that I, the tutor, didn't recognise. I didn't suggest any changes, however, and it 'worked': 30 or more people read it and came to the conference.

2.2 Meeting for Maths Students for Beginners

Including the organisers, about 40 people attended the conference. We started with food and drinks, identified by the organisers as a way of helping people to relax and meet each other. I knew about 14 of the participants (including the organisers) because they came from groups with whom I worked or from other centres I knew, so where possible I introduced people. We then sat in a large circle (herded into it by all the planning group). This account presents the planned activities listed on the Memorandum written by Shazia and Tracy (that is, the organisers' guidance sheet) and my recollection of the event.

'Bring in your own piece of work that you have done with Alison, you may also need to use some of your work for the display.'	I had imagined that we would need some materials to help people develop discussions and proposed to the planning group that I should bring some for display or group reading. I brought samples to a planning meeting, which no-one looked at. Someone at the planning stage said 'we can just put it on a table', and that was agreed. I brought a range of materials (e.g. extracts from Paulette and Cindy, Chapter 4) and most of the participants looked at them over lunch (from the start, at 12, till about 12.30) and during the tea break; many took copies. As far as I know no-one looked at these materials, or students' maths work, during the small group discussions. Around 12.30 the organisers asked people to sit in a big circle.
'Alison will make a small introduction'.	I introduced myself in about three sentences, mentioning how little research there is into adults' maths education compared to that of children.
'All of the students will stand up and introduce themselves'.	This didn't happen. It was probably my fault; I introduced Shazia and Sandra immediately after me.
'Then next Sandra and Shazia will make a small speech, representing the college'.	Sandra and Shazia stood and spoke, for perhaps two minutes each. They read aloud from prepared texts (I haven't a copy of these). There was a spell-bound silence and concentration while they spoke.
'There will be about 30 - 40 people coming, so that will mean that we will have to be divided into small groups ... Each of us will spread out and	The memorandum did not identify who was to organise this. I did it, and asked people (as we had agreed in planning meetings) to try to mix with people they didn't know. I asked people to form 'small groups', without specifying what 'small' might

form a group. We will then talk to our groups asking questions and perhaps taking notes. '	mean. Initially there were three groups, all about 8 - 10 people: one with Lorraine and Clare on the flat roof outside, and two in the 'barn-like' hall. One of these two groups, with Sandra, Violet and Tracy, moved into the classroom. The third group, with Antoinette, Jeremy and Shazia, got bigger and bigger as late-comers arrived. Shazia left the group to ask me to help her re-organise and split it; I did so, and she and about five people went off into a smaller room.
'At 2.30 Tracy will call everyone into the large hall. We will then discuss together the information that we have collected and share this with all the others as a whole. Claire is to make a final statement, she will also mention the newsletter.'	The meeting was 12 - 3: no other item has a time on it. By 2.30 most of the small groups had already stopped for tea and coffee breaks. All the organisers chivvied people back into the hall, and one or two people from each small group reported back. We listened to CAVE students, who read out a piece they had typed up during the conference (later included in *Global Maths*). Notes from the report back were given to me, and I also took my own notes as people spoke.
'Alison will be busy trying to make a small magazine together'.	This didn't happen. No-one did any writing for a magazine (though *Global Maths* later incorporated reports from the conference), and indeed beyond this statement in the memorandum we had not planned for it. I spent some of my time in one of the small groups and then decided that was not helpful, and hung around talking to crèche and cafe staff, welcoming late arrivals and paying out travel costs.

This photograph shows one of the discussion groups after their discussion.

2.3 The organisers' follow-up meetings

As people went home, seven of the organisers agreed to meet the following day (I also discussed the conference with Violet and Joyce, another participant, to ask their views, a day later). We met at lunch time on a bright, sunny day, and squashed onto the flat roof area outside the common room, eating an enormous cream cake provided by the Bede workers for 'the organisers of the best meeting ever'. Jeremy, Lorraine, Sandra and Shazia gave me writing they had written (independently) the previous evening, and we collected in notes from small group discussions (later included in *Global Maths*). I taped the discussion but made little effort to direct it; as well as the conference we talked about Tracy's trip to the USA, pregnancy, South London violence, racial harassment and gardening, amongst other things, in a mood of absolute satisfaction with ourselves.

In the following two sections I consider issues emerging from the conference. They are broadly divided into those relating to students' participation as researchers (section 3) and students' views on mathematics curricula, teaching and learning (section 4). My own list of issues reflects those identified by Tracy, delegated by the organisers to write a summary of conference findings for the later *Global Maths* magazine (Appendix 10, pp. 2-3). The discussion draws on my own notes of all the meetings, students' writing and the two taped discussions.

3 Participant action research: students as researchers

The student organisers took on roles as co-researchers at the conference. Rather than attempting to define *research*, in this section I explore the key elements of the conference, and surrounding activities, which together make a picture which I and the students call research.

My initial leaflet introducing me as a researcher (which the organisers had read several months earlier as part of their maths courses, at the stage when I asked permission to use their work in this research) defined research as 'asking questions'; in informal discussions in classes where students had agreed to take part in the research for this thesis, I had compared adult education to school education, and described class observation, interviewing teachers, testing children and so on in order to explain that there had been very little (published) research into ABE maths practice. I had also brought into my teaching some examples of research into adults' maths, inside and outside education (Chapters 2 & 3), and begun discussing the data emerging from my own research with students (in teaching and in informal conversations). For example, some of the organisers had read extracts from a tape of Paulette and Cindy (Chapter 4), who were unknown to the conference participants, discussing their maths work and criticising my teaching; the extracts show much we can learn if students speak to each other without the direct presence of a tutor. I was conscious of trying to include students who participated in the research in the developing formulation of questions and ideas. In a later article, some of the organisers wrote:

> *The students in this project [*Meeting For Maths Students For Beginners *and* Global Maths*] are researchers, and have a free hand to organise everything... We become experts listening to students from other centres, and students relate more easily to each other than to a tutor. We are in the same situation. (Gray et al., 1999)*

This research role is evident in students' work at every level (for instance, for Tracy's summary of the conference she re-read the available data and used her own memory of the event, as I have done for this chapter).

I go on to discuss

- research questions and small group discussion processes
- after the conference: deciding to produce a magazine
- unsettling ABE discourses
- factors contributing to students' success in research roles
- participant action research.

3.1 Research questions and small group discussion processes: before and during the conference.

The questions for small group discussions at the conference, typed up by Shazia, were based on the planning group's discussion at which I was present, but I barely recognised them and my own written record of them was very different.

> **Do you like math's?**
>
> **Was math's an easy or hard subject for you at school, and if it was, why?**
>
> **Why do you do math's ? Is it to help you get a job or perhaps to help your children with their homework?**
>
> **What are you most weak at in math's?**
>
> **How much further would you like to be educated in math's?**
>
> **Would you be interested in the inventors who discovered math's?**

How much important is it to you, to learn math's?

Do you think that math's is all to do with knowing how to do sums or is all to do with working things out in your own way?

Would you like to know if there are more than one way in solving a math's question or puzzle?

Are you afraid of exams?

Do you think it is all down to a good tutor to improve your math's

Do you think it would be easy for you to learn things by heart or by practicing as much as you can.

Some time do you think that just by looking at a math's question, you could tell the answer.

In some cases the questions were phrased differently but the content may have been similar. For example, Shazia asks

What are you most weak at in math's?,

I might ask

What do you want to work on in maths?

with the expectation that the answers might be similar. The difference may nevertheless be significant. Tutors, particularly those from the adult literacy tradition which calls for 'building on strengths', may be reluctant to ask directly for information on weaknesses. Shazia's phrasing suggests that students' shared positioning enables them to address issues more directly.

Three of the questions seem to arise from the organisers' recent experience of maths in the group with whom I worked at Bede. These all address issues of choice and cultural context:

Would you be interested in the inventors who discovered math's?

Do you think that math's is all to do with knowing how to do sums or is all to do with working things out in your own way?

Would you like to know if there are more than one way in solving a math's question or puzzle?

These questions are comparatively 'loaded'; they invite participants to seek wider knowledge (and perhaps refusal would suggest narrow-mindedness). The organisers all had experience of discussion and maths work around these questions in their own maths classes. Shazia's questions suggest the conference was seen by the student organisers as a way to share their own experience, as well as learn from the experiences of others; the questions illustrate for me whether their and my perceptions of what we do in maths classes match up.

I found two of Shazia's questions difficult to understand:

> *Do you think it would be easy for you to learn things by heart or by practising as much as you can?*
> *Some time do you think that just by looking at a math's question, you could tell the answer.*

In the first, the function of the word 'or' is not clear. Are the two parts of the sentence alternative ways of expressing the same idea, or are they describing different ways of learning maths? Is 'practising as much as you can' a way to learn things by heart, or an alternative to it? From my own experience of working on maths with the student organisers, I know that most of them find learning things by rote very difficult, so my interpretation would be that learning by rote and practising are two different approaches.

I have tried and failed to imagine what answers the student organisers would give to the second question. It seems to me very suggestive. It proposes a range of types of answer: perhaps sometimes you can answer questions by looking at them because they are too easy; perhaps visual information (the shape of a fraction? a graph?) gives the answer; perhaps sometimes you are much sharper and quicker at maths than usual; perhaps by standing back from a problem involving maths you can see an answer from a different perspective; perhaps sometimes a kind of magic springs to you from the page.

I find the question particularly interesting because I can 'see' clearly where most of the other questions are 'coming from', in our joint history in maths classes. Many of them arise from the students' interest in sharing what they have found best in the group's work. It is therefore odd that I cannot 'recognise' the last question (I have not found anything to illuminate this point in my other research data). This suggests that the students' and my perception and experience of maths, of our shared maths group, or of both are different. The fact that I do not easily understand the question may mean that we don't share the same ways of thinking about learning maths, despite my aim to strengthen student 'voice' and our experience of working together on maths problems.

In the event, the questions did not form a rigid agenda. These four organisers are talking about three different small group discussions:

Tracy	*Didn't you find that the conversation just, it just flowed?*
Sandra	*It just flowed, yeah.*
Tracy	*I mean, we didn't really get to ask the questions... I asked the*

	questions, in a gap, because I was asking different questions, I didn't know where I was getting it from!
Shazia	*Exactly, I didn't even look at my question sheet, I just, it just came out.*
Tracy	*Things that I really wanted to ask them, and I couldn't think, I thought I could go quiet, actually, I didn't have time to really write everything.*

Sandra	*... everybody was started saying things, which was interesting, so there was no point in asking the questions.*
Shazia	*Which was good in a way ... And people just wanted to get on with it, as soon as like lunch was over, it's like when can we start?*

Violet	*... what I was thinking, all along, what is it going to be like? You know .. what, what, you know that was the question keep coming to me. What? What? Until everybody came, and then we started to eat, and with the headlines, to give us a guideline on what maths, and all those questions, and then it just took off from there, which was great, and everybody had something to say, which would make the whole thing very (.) quite interesting, and I really enjoyed it. And people from different centres shared their points of views, and things like that, so it was great!*

Having established their own set of questions, the organisers treated them flexibly, so that the discussion evolved from other participants' interests too. Several asked the organisers for a copy of the questions, with the intention of raising the discussions in their own centres.

The student organisers spoke with great confidence during and after the conference about the maths curriculum (section 4). It's possible that they would have made such comments before the conference, but I think their willingness to argue with me, and perhaps any tutor, had grown. Despite this apparent confidence, the students clearly found that what they were doing was new and challenging. In discussion afterwards, it transpired that during a planning meeting Lorraine had a panic attack:

> *I just couldn't come out of one, I remember sitting there. That's why I went out. Remember I went to go in the room? It didn't start off as that, I was just like stressed out anyway. In my mind, all afternoon, it just felt numb, do you know what my head just felt numb all day.*

Shazia could not breathe the evening after the conference. Antoinette described the feeling of pressure on her chest: 'it feel like somebody just hold'. Sandra's asthma kept her awake every night for a week. Jeremy was 'petrified' on the day of the conference. Through these feelings of panic, they worked to organise an enormously satisfying event. Shazia felt under attack at one point: 'It didn't get me down though.'

So far I have described the student organisers' roles in research in terms of the detailed discussions in the conference. However, following the conference they also took on wider roles, planning future events and disseminating research findings.

3.2 After the conference: deciding to produce a magazine

During the post-conference discussion we agreed to produce a magazine or newsletter of writing around maths. At the beginning of the exchanges which led to that decision, it sounds as though the student organisers have already, independently, decided on the ways forward and need me to do the servicing work:

Shazia *Listen can I ask you something Alison, when are you going to get this thing together? During the holidays, or*
[I didn't know what Shazia was talking about.]
Alison *Well, I want to know what I'm going to do next, that's what I want to know.*
[Tracy evidently did know what's being talked about:]
Tracy *I'm missing it [because she was going to the USA]*
Alison *Get what together? What are we (.) what am I going to do?*
Shazia *The newsletter (.)*
Sandra *Newsletter and magazine*
[Mixed voices]
Jeremy *But why can't you, why can't we encourage some of the other people who come [to the conference] the other day, to write some things for the newsletter.*

Tracy had earlier, in conversation with another student, said 'If you're going to correspond with me, when I'm over there, I can sort of do something with you over there' - so the idea of the research was being carried overseas and into an unknown future.

In my experience this work is unusual; I would argue that these students were not 'helping' me with the research but doing it alongside me. The students here are proposing 'dissemination' of the research, though that is my term, not theirs; they are setting my agenda, the reverse of the usual ABE student-tutor role. The 'newsletter' became the magazine *Global Maths*, discussed in the next chapter; it includes the organisers' findings from the conference.

3.3 'You can tell the teachers from the students, they're very sort of loudly spoken': unsettling ABE discourses.

Throughout the thesis I discuss 'unsettling' ABE discourse; in this section I use evidence from the data to identify some discursive differences between the conference and more usual ABE practice. Students' challenge to the dominant voices of tutors is evident throughout, and so this discussion could be organised in a variety of ways. I have chosen to focus on how written texts were used, collective responsibility in discussion, and the identities of students as researchers contrasted with my own role and students' critique of tutors' usual discursive positionings.

3.3.1 Using written texts

The fact that the students, rather than tutors, organised the conference gave me some insights into both their experience of maths education and my own expectations from my history as an ABE tutor. Two pairs of written texts have already been mentioned: my initial leaflet inviting students to plan the conference, contrasted with the students' advert for the conference itself, and my (lost) notes of questions for the discussion group, contrasted with the list of questions circulated by Shazia. Here I discuss the students' flyer for the conference, and go on to the uses of written texts more generally. The flyer was a yellow A4 sheet, with a hand drawn map on the reverse. It is copied on the next page:

Bede Education Centre
351 Southwark Park Road
London SE16 2JW
Tel: 0171 - 237 - 3881

MEETING FOR MATHS STUDENTS FOR BEGINNERS

To be held on Monday 14th July 12-00 - 3-00, at the Bede Centre in Abbeyfield Road, SE16 - about 400 yards from Bede Education Centre.

Please come and join us to discuss your ideas and views on maths. We have discovered that there is more to it than numbers! We have so far learnt some of the inventers who have discovered maths; where maths was discovered; how the numbers have changed in writing; the different ways in which other countrys used maths eg. Egyptians, Russians. We have found many ways which suit us when we are doing maths. We are no longer afraid of maths. It is now fun to do. Maths is everywhere you go; you deal with it every single day and you might not know it. Maths is in politics; when you go shopping; when you look at the time and when you plan your day. There will be other students from other colleges too. It would be great to find out what people think about maths, and to see how we can share our opinions. Bring a bit of maths that you have done from your college, and if you have any problems than we will try to solve them together.

There will be free refreshments and also a crèche will be available. If you do need to use the crèche then let us know a week before hand. There is disabled access to the building, if you think that you might not be able to enter the building. If you have any problems with the cost of travel, travel expenses will be paid for after the meeting.

If you are coming, please send this slip to Bede House by the 7th of July.

See you then!

Name Address and/or Telephone

Name of college
Crèche places: Children's names and ages:

Please say if you need help from us entering the building:

I was delighted but not surprised to read in the conference advertisement that the students were 'no longer afraid of maths', and thought 'It is now fun to do'. But they also said they had learned 'where maths was discovered' and 'the different ways in which other countrys used maths e.g. Egyptians, Russians'. I can square 'where maths was discovered' with having done some work in the group on the social construction of maths - though on the surface the claim is quite the opposite and implies a Platonic view of maths. I may have mentioned, or shown, what is sometimes called the 'Russian peasant' method of multiplication; I had said something about the use of 'Pythagoras' theorem by Egyptians and Babylonians and probably at some stage I had said many of the 'Greeks' were Greek-speaking Mediterranean islanders and Egyptians. It seems that what I saw as quite small remarks had taken on a large significance to the students, not only as examples of general themes (sexism and racism in the way maths history is written, for example) but as topics in themselves. The organisers' writing of the advertisement therefore led to insights for me into how the meanings they take from our shared experiences differ from my own.

Most participants didn't do any writing at the conference (though many later contributed to *Global Maths*). I took tape recorders but none was used. Student organisers all took notes during the conference, and Shazia, Sandra, Clare and Jeremy used their notes as a basis for reporting back from discussion groups, at the end of the conference. These are all people who identify themselves as having problems with writing, and attend English classes as well as maths. This suggests that the organisers saw a written record as very important, and may relate to the status accorded to written records, to respect for the content of the research and hence a desire to make a comparatively permanent record, or to both. It is notable that the only (very formal) written response during the conference from non-organisers was by people who came together from one centre and who were accompanied by two tutors. I wonder (and can do no more) whether more students would have written had support been available in the form of a tutor to take dictation, or whether the writing was initiated in some way by the tutors.

A conference organised by tutors would, I suspect (based on experience), have proposed each small group share a reading to get discussion started. These discussion groups had only the spoken word to start them off (some organisers didn't use Shazia's questions; some veered off them; if they did use them they were not available for other participants). The conference was kicked off with Sandra and Shazia reading aloud from their prepared speeches, with shaking voices, in an atmosphere of tense, concentrated silence. Written notes, then, were seen as appropriate ways to start and finish. I took notes of the final discussion and reporting back: Lorraine laughed, and said 'You took notes of notes of notes of ..' The following day Shazia, Sandra, Jeremy, Antoinette and Lorraine gave me some writing (notes of discussions, or their own responses to the day) produced independently in the evening after the conference.

Reading was not used as a stimulus for group discussion; participants were not invited and supported to write during small group discussions; organisers took notes despite their difficulties with spelling; people who 'can't write' read out their own entirely independent writing, to a large audience. Students wrote substantial commentaries on the conference in their own time without any suggestion from a tutor - something that would often be assumed to be 'too difficult'. So the group's choices about reading, or not, and writing, or not, went consistently against my experience of previous events involving students. The students too viewed this as a significant shift in discourse patterns: as we shall see below, they wondered if a tutor felt 'threatened' by the organisers' taking notes.

3.3.2 Collective responsibility in discussion

I have already described students' use of their own agenda for the small discussion groups, and the fact that my agendas for planning meetings were ignored and students took on the function of getting the group back 'on task'. Here I discuss the less formal follow-up discussion. It is a wonder of cross-woven strands; most of the discussion is on at least two or three separate topics, occasionally brought together onto the original topic, and much of it is impossible to transcribe. Here are two examples.

Some drifted onto discussion of a recent murder, near one of the centres where I work. It was a shooting. Tracy said 'We've left the subject':

Alison	*That's alright.*
Tracy	*We're not on the same thing. How many millimetres will a bullet shoot from a gun? [laughing]*
Lorraine	*Nought point two innit, Alison? [everybody laughing] Is it point two?*
	[Some discussion of gun sizes - point two two?]
Alison	*But I don't know point two two of what it is.*

So 'the subject' is treated ironically.

Later, someone started taking photos; some started talking about Tracy's recent disaster with a camera at the zoo; and the tape loses the detail as several conversations continue at once. The confusion clears, and we hear this:

Tracy	... had an argument with this friend that the camel was dead, when it was just laid there.
Shazia	So so far what we're going to do we're going to wait until September.
Clare	Yeah, if we say the end of September.

I suppose this represents the end of an anecdote, Shazia summarising the formal 'business' so far, and Clare confirming it. We went on to decide deadlines for the newsletter.

These jokes, anecdotes, fringe conversations and diversions would not normally be an acceptable part of ABE discourse led by a tutor. Probably they would never get started; if they did, the tutor would get the group 'back to the point', a point decided possibly by the tutor, possibly by the group as a whole. It seems the group collectively was able to keep in mind several trains of thought at once, sharing responsibility for making sure everyone was heard.

3.3.3 Personal identities, roles and power relations

The follow-up discussion shows us establishing common identities on non-educational territory. For example, we shared discussion about racism (part of our shared culture, in terms both of life in London and the TV programme which started off that topic). All the women shared jokes and discussion about men, pregnancy and periods. It's likely that discussion about money (for example, Radio Rentals' computer costs, lawyers' pay and pay for USA nannies) was linked to an identity related to shortage of money. These non-education exchanges may all work to undermine the gap between me as a white, middle class tutor and the students, majority black and all working class, since they sideline the student-tutor relationship which carries particular power relations.

In some contexts the students identified me as something other than a tutor (maybe as a researcher): Shazia's comment 'Tutors, I thought there was no tutors!' (discussed below) wouldn't be made if she identified me at that moment as a tutor. But Lorraine very exactly pointed to discourse practices identifying tutors and students:

You can tell the teachers from the students, they're very sort of loudly spoken.

I suspect that by 'shutting up' (for example by not attempting to chair this discussion) I was trying to camouflage myself in the students' discourse. Lorraine here points to the need for tutors to 'keep their voices down', metaphorically as well as literally, if we are to unsettle the traditional patterns of ABE discourses and make space for students' voices.

The conference had been advertised as 'for maths students for beginners', yet one group of students came accompanied by tutors (this may suggest that tutors are used to positioning students as dependent). A developing debate over the position of one particular tutor[1] led to these comments, which apply to all tutors:

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[1] I think the debate was important, new to the field and useful to the research; I also very much doubt that the tutor knew that s/he was irritating the student organisers, who stressed they did

> *Tutors, I thought there was no tutors! At the back please, keep quiet, just take notes, I felt like saying. (Shazia)*
>
> *The thing is, I think the tutor should have took a back seat and let the students interview the students, and just listen to what's being said. (Jeremy)*
>
> *The whole idea ... was for the teachers to listen, and take notes or whatever, and for us to do everything. (Shazia)*
>
> *You need to make that clear. (Jeremy - applying the lessons from this conference to any future conference)*

It is tutors' responsibility to shift roles (in Lorraine's terms, to speak less loudly):

> *I think a lot of tutors, if there was tutors there, would have most probably thought of more ways to change. (Tracy)*

This was the impact on Shazia:

> *S/he kept on asking questions, s/he was directly looking at me, and like (.) do you know what I mean? I felt really intimidated.*

She analysed what had happened in her group:

Shazia	*But s/he sounded as if s/he was annoyed. S/He probably thought I was a teacher or something, I don't know, I mean I tried to get everybody to talk, and s/he probably must have felt as if I'm asking all the questions.*
Tracy	*Taking over, maybe, or*
Shazia	*Taking over, whatever, because I'm taking notes at the same time*
Tracy (?)	*Maybe s/he felt threatened.*

The student organisers in the tutor's small group saw him/her as dominating discussions and pushing a particular curriculum view (discussed in section 4); they were furious at being told what they should want to learn. I knew the tutor well enough to think it very likely that s/he was trying to get to an understanding of the students' views of maths, and trying to make sure that her/his view was understood - no more. I was not able to persuade the student organisers that anything positive had come from what seems to have been an unduly sharp debate, despite the fact that a (different) tutor specifically said that s/he was impressed by the case made by the organisers for studying the history of maths, and would consider changing their curriculum.

This is a privileged opportunity to see ourselves (tutors) as others (students) see us. These students (all the student organisers supported Shazia, Jeremy and Antoinette, the organisers in this particular small group) see the rigidity of student/tutor roles as rooted in tutors' insecurity and position of authority. This specific challenge from the students, as well as the overall tone of the conference, suggest that if we are to make progress in joint

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not want the individual to be publicly identified. I have included the bones of the criticism here while as much as possible removing it from context and disguising the individual.

projects with students we need to work on understanding and articulating the relationships between tutors and students.

3.4 Factors contributing to students' success in research roles

If we are to get longer-term, wider-spread, more secure access to the kinds of knowledge students can develop through participant action research, we need to consider what factors may have helped this group work in these ways. I have already discussed changes in discourse patterns. Here I want to highlight some practical contexts: funding, the organisers' prior experience, institutional support and my own role.

I imagine that the conference would have turned out quite differently if we (the conference organisers) had not had some money available. All the organisers and those of the participants I knew were living on benefit and/or poorly paid part-time work. I used money from my ESRC grant (identified for payments to 'informants' - we had much chat about grasses, narks and the like) for the crèche, food and travel costs (for the four planning meetings and for the conference itself). Paying for travel enabled us to use a community centre which was offered to us free but is difficult to reach by public transport. The total cost was about £350. Though that is tiny compared to most 'research conferences', it is an important issue to consider since the funding for most AE is not sufficiently flexible to incorporate such meetings.

Most of the Bede student organisers attended classes at Bede before I started there - that is, they knew the buildings, other students and some of the staff better than I did. Two were part-time crèche workers. Given their knowledge, it was easy for me to 'shut up' and agree to their suggestions. The life experiences of the 'core' group, briefly listed above, had perhaps led to their particularly good organising skills. Their purpose in a meeting seemed to be to come to a good decision; at no point did anyone argue for an idea simply because it was 'theirs' rather than someone else's. When I said that in a meeting of tutors we would probably have debated something for half an hour, someone said, 'Really? Why?' Their approach is illustrated by Shazia's comment while the group was collectively drafting a letter: 'That's good, pass it round, it's all coming together', where 'Pass it round' means 'share the ideas'.

I realised during the planning process that I was learning from the students. This is a common-place of literacy education, and usually refers to learning about the students' experiences (Freire, 1972b) and respecting students' expression of that experience. I was learning more than that. For example, as responses rolled in from the conference advert the students wrote, I realised it was good - it worked; they had written a better advert than I could (recall that the leaflet I wrote, inviting people to plan the conference, had been unclear and confusing). They ran planning meetings which covered all the business, started and finished early and involved every participant. They led small group discussions which involved all participants. They argued for and against specific elements in the curriculum. They did all this while speckling their conversation with jokes and self-criticism.

My own role in the conference is clearly important. Though I have argued the students steered agendas, I could have prevented them doing so. The conference was 'educational', in that its subject was education and we all learned from it. However, I consciously tried to avoid 'teaching' or 'sharing my experience' and worked to go along with the students' suggestions as far as possible. This implies we were not working as 'equals'; I was in a position to decide whether or not to 'go along with' the students. However, I argue that as the planning and organising process went on, I retained all the authority teachers usually have, but its impact on the conference was reduced.

This was a self-selected group, presumably made up of people who have an inquiring interest in education rather than an instrumental 'get the certificate' approach. Most of the organisers were members of a centre which seeks to listen seriously to students' views and the culture of the centre itself probably contributed to the group's success (Open Learning in Adult Basic Education Research Team et al., April 1996); the Memorandum says that Sandra and Shazia 'will make a small speech, representing the college' - that is, not 'the students' only. Most of the organisers came from classes I had taught; there, too, I had been trying to unsettle authority relationships. There is a danger in writing this that I may seem to re-centre my own role ('radical tutors empower students so they are enabled to organise conferences', perhaps). I shall argue in the final chapter that making it possible for students to feel in control is not the same as a 'giving' of confidence, where the tutors are the agents of action. I suggest here that my 'shutting up' made space for students to use their prior skills and knowledge; that is, to 'build on strengths' (Chapter 2) which otherwise I would not have known they had.

3.5 Participant action research

In keeping with the model of PAR described by Merrifield (Chapter 2), the conference was

> *owned and controlled not by researchers but by people ... who need the research to act on issues that concern them. (Merrifeld, 1997)*

In terms of the classification of ethnographic research by Cameron et al. as ethical (*on* subjects), advocacy (*on and for* subjects) or empowering (Chapter 3), this is consistent with the last: *on, for and with* subjects. Cameron et al. argue that the standards of objectivity and non-interaction will not be appropriate in 'empowering' contexts, and propose the use of interactive methods, subjects' own agendas and clear feedback and sharing knowledge (Cameron, Frazer, Harvey, Rampton, & Richardson, 1994: 23), all evident here.

There are many parallels between students' work around the conference and my own in the research leading to this thesis. Student organisers were developing analysis from their own research; their findings are being distributed through this thesis, *Global Maths*, conferences and articles (Gray et al., 1999; Wilson & Tomlin, 1999) and word of mouth. We also shared many emotional responses: sleepless nights, anxiety, pride, celebration. The differences in our work are partly to do with the different discourses within which we share findings. My own work will be formally examined and accredited, as part of approval for entry into academic discourse. I am required to engage with the research in particular ways; in Gee's terms, my Discourse, enacting a specific identity and activity, will be 'recognised' (Gee, 1999: 7). The students' work has far less academic constraint and recognition. However, in our shared work that formal discursive difference was not the most important. More significant was the vastly different experience we brought to the research. The students are inside the world they are researching; they are truly 'participant' in a way I cannot be (and I have highlighted evidence that we took different meanings even from 'the same' class or piece of writing).

Positioning students as researchers uses their knowledge and discursive positioning as ABE students - they know (in a way tutors cannot) what 'they' need or want to learn in mathematics education, and they are not divided by authority roles and institutional structures from other students. The scare quotes are to remind us that 'they' are not a homogeneous group and may have different interests, demands and styles of learning, as indeed the conference found. A further difference between the students' experience of research and my own lies in their joint work and mutual support which contributed, I would argue, to their strength in resisting tutors' authority, in both curriculum issues ('That's where you're wrong') and wider approaches to learning ('Tutors!... keep quiet, just take notes..').

In my discussion of participant action research (Chapter 2) I raised questions about the meaning of 'action', and suggested that although much participant action research within literacy has no obvious 'action' in the sense of achievement of change, it suggests a move towards what might be called meta-knowledge of the discourse of adult literacy education, or critical analysis of the discourses of literacy. Similarly here the 'action' is difficult to define. Of course the conference involved 'action', in that people were brought together, a magazine was produced, and so on. However, I would suggest that the key outcomes also include the critical analysis of practice in adult education mathematics education, in a context of building theory.

I turn now to discussion of maths education, generated through the conference by students' participation as active researchers into their own and their fellow students' experiences and demands.

4 Students' views of mathematics teaching, learning and curricula

I will start with specific suggestions from the students at the conference for the content of mathematics courses for adults, including discussion of tests, fractions, decimals and percentages, and calculators, and go on to more general views of the culture of the maths classroom and the meanings and uses of maths and maths education.

4.1 Tests

Several of the groups at the conference reported concerns with test taking. These quotations are from my 'notes of notes of notes' (Lorraine), written during the small group report back session, or from organisers' notes of small group discussions, used as a basis for their report back:

> *People want exams to show they have achieved something. (Clare)*
>
> *Test-taking techniques very helpful. (Mario)*
>
> *Exams put people under a lot of pressure. You need to practise. (Tracy)*
>
> *People wanted to improve their maths work, i.e. sit exams and catch up with lost years ... People felt we should have more practice with exams in the classroom. (Sandra)*
>
> *Need to practise for tests. (Jeremy)*
>
> *Need mock exams to practise. Some people like multiple choice questions rather than ones where you have to work it out. People can take exams and are no longer afraid. (Shazia)*

These comments may be either a response to the question on Shazia's sheet 'Are you afraid of exams?', or an indication of students' general concerns about exams. They show a tension between wanting examinations as evidence of achievement, and the 'pressure' they produce. In recent years funding regulations have been used to force FEFC-funded providers (that is, the vast majority) into accrediting all adult basic maths work. These comments seem to suggest that most of the conference participants were taking exams rather than coursework-based accreditation.

4.2 Decimals, fractions and percentages

The only area of a maths curriculum which was specifically mentioned was decimals, fractions and percentages. They evidently loom large on the students' horizons as stumbling blocks (and this is confirmed by other fieldnotes from class teaching). I discuss comments from the conference itself and discussion at the first follow-up meeting. I then describe what happened when I raised similar issues in a class meeting the following day - the whole group took up the fractions topic.

These opening comments are from Tracy's summary for *Global Maths* and students' written notes of small group discussions:

> *Fractions and decimals are such a common problem.* *(Tracy)*
>
> *Most did not like the fractions, long division and %.* *(Shazia)*
>
> *We had different problems with different maths, e.g. percentages, fractions.* *(Lorraine)*
>
> *Fractions are now more important in accounting than they used to be.* *(Mario)*
>
> *Fractions, decimals are found to be the hardest.* *(Tracy)*
>
> *Figures; fractions; percentage.* *(Jeremy)*

Tracy associates difficulty in dealing with decimal place value with using a calculator:

> *It's funny, everybody finds fractions, and decimals, a problem. And it's funny, because I thought, it's just me ... that can't seem to get converting even though I couldn't get the place values of decimals correct, and I mean if they'd have turned around to me and says, 'This sum, what place value is this?', I'd have walked out the room, because I wouldn't have known, but when everybody in the room [conference] confess oh no no, too many figures, too many numbers, I mean, I'm only 22, and I'd rather use pen and paper than use a calculator.*

In Shazia's account, percentages are linked with long division; perhaps both are emblems of the traditional maths curriculum:

> *Some of them, found long division hard, and what happened was, they learn it, when they're doing it in classroom, they learn long division and percentages and after a short while they forget it again, it's like you have to keep on doing it. (Follow-up discussion)*

At the first follow-up meeting we had a disagreement about my own ideas about the curriculum. I said I thought fractions were not useful in 'real life', and I was tackled by Jeremy, Tracy, Shazia, and Antoinette:

Alison	*The fractions, you just don't use it in real life, at all, ever, I don't think.*
Jeremy	*You do, you do, you do.*
Alison	*When?*
Tracy	*Actually I think you do.*
Jeremy	*That's where you're wrong, because the thing what I, the topic I*

	was studying [accountancy], right, they had to write all the fractions out in the book for you, so you could work out the 8%, the 10%, the 15%, 25%.
Alison	*Oh yeah, percentages, yeah.*
Shazia	*Percentages, but that comes into fractions as well, doesn't it. 25% is a quarter.*
Alison	*Yeah.*
Jeremy	*No, no no, no, but they show you the fractions, like say you've got a 100 pounds, how to work the VAT at 8% or 25% or 15%. To make sure you got it right, they worked (.) they did the fractions, and they were put beside the percentages.*
Alison	*Right. But you can, you see, you can do percentages by decimals instead of by fractions, and I think it's easier. If you do it by decimals, I think it's easier.*
Shazia	*Quick, write that [i.e. the method] down! [laughing]*
Lorraine	*Show us how you do that.*
Jeremy	*That's what it was in the book, and it was quite clearly explained.*
Antoinette	*We went to a shop, a store, and they have (.) three third (2)*
Alison	*A third, a third off, or something.*
Antoinette	*Yeah.*
Shazia	*Yeah, you do -*
Alison	*Yeah, it's true. Ok, I'll back down.*

Here the students not only challenge my view of what maths is should be included, but demand I give them the techniques they want ('Quick, write that down!'). The question of fractions arose from conference participants as a cause for concern in maths education, so here the student organisers are defending their informants' arguments.

The discussion made me realise that students saw me as being too general in my argument against fractions. I still believed that in everyday life people did not need to use more complicated fractions, but recognised I needed to distinguish between these and Antoinette's 'a third off'. The following day, in an end-of year class meeting I discussed the conference with Violet, an organiser, and Joyce, a participant. Most of the students in their class were going on to GCSE. I raised the issue of fractions: I explained the entrance test for the GCSE course included fractions, and commented that though understanding the 'rules' is essential for further work in maths,

> *things like five sevenths multiplied by four fifths ... you never do it in your normal life, do you?*

Joyce agreed,

> *You learn it, and then you forget all about it, because it's never necessary.*

Violet made connections to 'real life':

> *It comes a little bit in percentages.*

This was not a 'class', but a year review discussion. The group had already worked on the only 'mathematical' agenda item I had brought, but now my mention of fractions launched them into revision practice, starting with my example of 5/7 x 4/5. I tried several times to divert the group from what became their own agenda, the minutiae of rules for fractions calculations; they worked on the example I had given and produced their own, checking division and addition as well as multiplication. After I had succeeded in changing the topic, they came back to it:

> *Well we still want to learn, what we take this thing for. Right ... this is something I want to remember, as I go along... the multiply. (Joyce)*

Dave worked on 4/5 ÷ 4/5, and came up with 20/20; he was not interested in my comment that the question could be rephrased as how many four-fifths are there in four-fifths, and 20/20 being the same as 1.

The students' commitment to a 'meaningless' fractions discussion (traditional, formal algorithm practice), raised by me exactly to illustrate its lack of connection to 'real life', reminds us that their lives include the desire to further their education and to recover from earlier defeats. Joyce telephoned me after she had started GCSE to ask whether I thought she could 'really do it' - the 'it' being more advanced maths; she was thinking of dropping out. She was critical of the course for making student mutual support very difficult. So the discourse of the course is what gives meaning and determines students' relation to the mathematical work.

4.3 Calculators

There was no specific question on the use of calculators, but many participants discussed it. Conference reports include these comments:

> *Sometimes people don't trust them because they are nervous of pushing the wrong buttons. (Small group report back)*
>
> *Everyone agrees to work out the sum first then check it with your calculator, because some were afraid they would touch the wrong button, or it would take a long time to work. (Sandra)*

The students' experience of calculators is apparently centred on calculating by hand and checking by calculator. Caution about calculator use centres on the numbers' disappearance as the next number is entered. (It seems none of the students had access to graphical calculators, where the numbers and operations remain on the screen and can be visually checked.) Any error in entering a number, or an operation, can only be checked by re-doing the calculation - as many students do. Many people more confident with calculation probably use a calculator first and check with mental estimations - that is, they check the calculator, rather than using the calculator as a check for mental or pen-and-paper calculations. Tracy (above, associating calculators with decimals) implies that younger people are usually happy with calculators; the comment that students are 'nervous' is consistent with older people trying out new technology. There was no mention of calculators as a tool for learning.

Since the conference, calculators have been in the news with the (mis-)reported rejection, in the National Numeracy Strategy, of calculator use in the early years of schooling (Brown, 1999), and so the topic has arisen again among adult students. Several students commented that calculators 'stop you thinking', and my impression is that there is popular support for limiting the use of calculators. I discussed above (Chapter 2) the introduction of research materials into the maths classroom. A better informed debate, on both the use of calculators and the discourse which links poor maths 'performance' to their use, could perhaps be generated if we similarly made research materials on the use of calculators available to adult students.

4.4 'Lots of ways of working out maths'

So far I have discussed particularly formal and difficult elements of the traditional maths classroom: tests, fractions and the debates about calculator use. These clearly are foci of students' discussions of maths curricula. However, the whole tenor of the conference celebrated difference as well as commonality; different mathematical approaches are also welcomed.

> *There are different ways to do maths. You can make it easier and simplify it.*
> *(Jeremy's report back)*
> *A lot of people are better at mental arithmetic rather than on paper.*
> *(Shazia's report back)*
> *There were so many ways to answer maths questions, and different maths to work out.* *(Lorraine's post-conference writing)*
> *Many different ways to do maths.* *(Mario's small group notes)*
> *There are lots of ways of working out maths.*
> *(Not signed; probably Antoinette's group)*

4.5 Academic and 'real life' curricula

There was a consensus on validation of a choice of methods or techniques. There was also considerable debate about broader questions, couched largely in terms of 'every day' or 'real life' maths as compared to 'textbook' maths. One strand in the conference, the written reports and the follow-up discussion was around broad views of ways of defining a maths curriculum, including contexts for maths skills. There were too many comments to quote them all here. Typical are these two:

> *Most students want both <u>text</u> and <u>everyday</u> learning. (Mario's notes; original emphasis)*
>
> *Maths helps you get a job, helps with your shopping, measurement, your money, i.e. bills, and if you have children you now can help them. People wanted to*

improve their maths work, i.e. sit exams and catch up with lost years. (Sandra's notes)

Jeremy complained about poor curriculum design from one of his previous tutors ('this girl'):

Jeremy	*...this girl went on about hectametres, dectametres*
Shazia	*Oh god*
Jeremy	*And they absolutely confused the issue, right*
Tracy	*What are they?*
Shazia	*Really really old*
Jeremy	*Really just centimetres, right, you don't need dectametres, stick to centimetres and people will understand it. What's a dectametre, what's a hectametre? and everybody was absolutely thrown.*

(from the follow-up discussion)

Here Shazia's 'really really old' suggests that the problem is irrelevance, yet relevance is not elsewhere defined in terms of immediate utility. It seems from discussion at the follow-up meeting that one tutor (identified above as 'taking over') argued for 'everyday' maths and saw that in contradiction to 'textbook' maths. Antoinette was angry that the tutor seemed to be defining her maths needs for her:

When me and Jeremy was talking about what we was doing, the [tutor] was saying that you need maths, um, for measuring and all of that thing what you is doing, and I thought, how can [s/he] ask those questions? Why can't [s/he] just go.

Shazia agreed, and added,

You know the one that got me ... is the one with, which is the best thing, going through textbooks or doing what you [Alison] do with news articles... and I said both, I said both.

This discussion holds two lessons for us, I think.

The first is that students are passionate about their entitlement to a full range of maths and want the right to make their own choices about what they study. No-one objected to the idea that they might study measurement, money and so on - the usual 'numeracy' curriculum as defined in Britain (Chapter 2). They were not happy to have this defined for them as the total range they could work on. Shazia said to me that her work in the Bede maths group, set up for the research, had 'spoiled' her for other classes; she 'loved' the political work we did. Sandra then said she got 'bored with your political worksheets'. The students' case is that maths education needs to be wide and flexible enough to incorporate such differences in interests.

The second lesson is that we are too crude in the ways we describe the curriculum. I found it hard to follow the discussions at some points. Some participants placed textbook maths, looking at the history of maths and maths from the news all in the same category, and contrasted them with practical or 'everyday' maths; others put news-based worksheets in a separate category from textbooks. Adult education (and FE) typically offers 'basic maths', or 'numeracy', in the programme, with no description beyond possibly a list of questions designed to identify potential students ('Do you want to brush up your maths?').

Embedded in the debates at and after the conference are arguments about the social construction of maths, the uses of maths, hierarchies of concepts within maths and so on. I would argue that we need as tutors to clarify our terms and to find ways to open up the debates with students.

4.6 'Good' teachers and classes

Conference participants made suggestions about the organisation of teaching. The following comments come from written notes after the conference:

Classes should be kept small:

> *Teachers should set a good standard in teaching, and must have time and patience. It is hard when there are large classrooms, therefore there should be a good ratio. (Shazia)*

Whole class work may not suit all students:

> *It is a question of being pressured. Some of us found it difficult to ask too many questions, and sometimes felt pressured when having problems with work. They felt that they were slowing the others down. So this is why some like to work in a group and some individually and some both. (Shazia)*

> *People felt they have to have a good tutor, but sometimes they can have conflict. In the classroom some people can work as a class and others left by themselves. (Sandra)*

Students should feel that learning at their own pace is an entitlement:

> *Tutors get paid to teach, yet often, students don't benefit and don't feel <u>entitled</u> to being taught/shown things. (Mario, original emphasis)*

> *If it's a good tutor then you're ok because it is down to the tutor and how relaxed you are with him/her. (Tracy)*

There are few explicit claims about what makes a 'good' tutor, but there are implied shared understandings, which centre on the students' perceptions of whether the tutor listens - that is, whether the tutor values students' voices. Concepts such as patience, conflict, entitlement, pressure and relaxing all refer to classroom discourse and centre on the group or individual learner's relationship with the tutor.

4.7 Maths, community and respect

The overwhelming impression from the small and whole group discussions is that people were delighted and encouraged to find they had so much in common with each other. There is no doubt that the conference lessened isolation and developed a sense of common purpose. Within that, there was a strand of discussion about differences:

To my amazement I was quite astonished to find that we had similar ideas and thoughts. And some people yet thought so differently. (Shazia, written report)

One key difference is age. One of the projects represented at the conference was specifically for young people (up to 25); the conference was also attended by at least two people in their sixties or seventies. There was no agreed recommendation about mixing ages, but it is clear that age should be considered when organising classes, and students should be consulted on what age group they would like to be with. Joyce commented that she was surprised to see younger people at the conference; I think this came from an assumption that the younger generation had better schooling than her own. When Joyce and Violet discussed the conference they moved into a discussion of their roles and parents and their experience of education as children; there is a strong sense of generations.

One older man was described by the organisers who met him:

Antoinette	*That man, he was talking mostly about students being in the class younger students than himself.. He was saying that when he first went into his class, he felt a bit bad, because [he's in his 60s]. And he was just looking at me when he was saying that! You know? [Antoinette is about 19]*
Shazia	*But in the end he got used to it because he was like he wanted to confront maths, all this time all these years, and now he felt that he was ready to face up to maths, and to show his children and grandchildren.*

It seems that the organisers, at least, were very impressed by older people's return to maths education; this may mean that they had, until the conference, seen maths education as something older people would not be engaged in. As well as the older man discussed here, they talked about what they had learned from an older women:

There was a woman in our group, and I just wanted to let everyone just clap for her. She must have been at least 70 years old... And one day a week she went to school from when she was little, all she could go was one day a week. She was so determined to do it, and I mean even now every day she's been determined determined determined determined to do it, and she's still going, she's still doing it. And I felt really proud of her, it's determination that she had. (Tracy)

This woman is both an inspiration from outside, and a part of this maths community ('I felt really proud of her'). There is a strong sense throughout the discussions of community: learning from and respecting elders; seeking to support younger people; appreciating difference and individuality; working together. Although the 'official' topic was mathematics, many comments carry the tone of witnessing; maths education is set in a context of community and individual development and mutual support.

Seeing themselves as researchers did not distance the student organisers from other students, at least in the organisers' minds:

Tracy	*All the people were different, and different ideas. To be honest I thought they'll all be cleverer than us, or we'll all be cleverer than them.*
Shazia (?)	*That's the way I thought, that's the way I thought.*
Tracy	*but everyone was all just on the same level.*

Shazia wrote

> *There was a lovely sort of atmosphere, and warmth. It was as though we all knew each other.*

4.8 Maths and confidence

There were many comments at the conference about the need to make maths 'fun', and its positive benefits in practical matters including shopping. It is however also something 'other', demanding confrontation and courage. Success in maths may prove intelligence (Tracy's comment on 'cleverer', above) and determination, and will contribute to employment chances. This is illustrated by an account by the student organisers of the impact in their families of their maths studies:

Tracy	*My brother was saying to me I don't know why you went to college in the first place because you quit now, because he always tries to put me down a little bit, you've quit now, what have you learned, you've got to show me some proof that you've learned something.*
Jeremy	*No, you don't have to prove yourself. [Everyone talking.]*
Tracy	*And my mum's gone to buy a cooker, and she said, she said 'Oh look, 20% off', you know, 'I can save myself twenty quid' she was saying, 'and I can do this and this' and I said, 'But you don't save yourself twenty quid', and I shown her how to work it out and I looked at my brother and I said 'Could you show mummy that?' I said to him 'are you deaf?' [?] and I walked out the room [people laughing], and it was just such a come back, you know, and wind him up a little bit more.*
Sandra	*(laughing) Good for you!*
Tracy	*'Did you know that?' I said to him, 'actually I can show you the certificate where I got a Distinction, which is not something you would understand. But it's a first class pass you know, first class same as a stamp', I said to him you know.*
Shazia	*Yeah I know what you mean Tracy. I kept my sister quiet for a minute and that is saying something [laughs]. It is a boost, yeah, to shut them up.*
Tracy	*And say excuse me, I happen to know what this is [....] I don't want to live off your tax, I'm going to do something, after I've finished all of this, and I'm going to (.) be paying so much tax you're going to want to live off my tax, sort of thing.*

Here the proof of Tracy's learning lies in both the certificate and the practical ability to apply and teach percentages. This account led to Antoinette's similar story:

Antoinette	*[someone said to me] Why don't you go and get yourself a job instead of just going to college, it's because you don't want to go out and work, and I say, that's not the reason why. I want something better out of life.*

In discussion about what that 'something better' may be, the students extended the description of what they had gained:

Tracy	*but you know what you gain?*
Shazia	*Knowledge.*
Tracy [?]	*You've not just gained knowledge, being able to spell, and read and write, but you've learned [inaudible]*
Shazia [?]	*You've learned to socialise.... to get to talk to people at any other age, no matter what their career, their things, what they do, you know, you can just talk with anybody.*

Maths education for these students is a route to improved employment prospects and improved management of household affairs, but also a way to gain family and social respect and self-respect. Learning to 'socialise' suggests that it is important that maths courses allow students to develop relationships with each other. This exchange gives us some context for the passion with which they argued against a more restricted view of a maths curriculum; it is central to their lives. The comments contribute to an emerging picture of confidence as a measure of success.

5 Summary and themes

Sections 3 and 4 have described students' work as researchers and their views on maths education, grouped into key issues. Not all these will be taken forward as themes for the overall thesis, but it has been important to record them here. There is remarkably little written evidence of students' views on ABE maths, and the conference and later magazine (Chapter 10), are (I believe) unique sources.

In Chapter 3 I discussed Cochran-Smith & Lytle's (1993) claims for teacher research. They propose that theory is a combination of interrelated conceptual frameworks grounded in practice, such that teacher researchers are both users and generators of theory. Teacher researchers, they argue, have ways into research which are closed to non-teachers, since teachers' perspectives

> *[encompass] knowledge of content, pedagogy, curriculum, learners and their characteristics, educational contexts, purposes and values. (Cochran-Smith & Lytle, 1993: 17)*

I make a similar claim for student researchers. Their knowledge is differently based, embedded in their experience on the receiving end (in school as well as AE) of institutional and professional practices. However, that does not mean their knowledge is less soundly based; indeed, without their perspectives any research into ABE is itself significantly weakened. I would add to Cochran-Smith and Lytle's list of areas of knowledge: student researchers also know 'teachers and their characteristics'.

Sandra Harding argues that

> *a maximally critical study of scientists and their communities can be done only from the perspective of those whose lives have been marginalized by such communities. (Harding, 1993: 69)*

Similarly, a critical view of ABE tutors and research demands the perspective of ABE students.

The students whose work is reported in this chapter know that, because of their personal identities and histories as maths students, they have ways into research that are closed to tutors. They are self-conscious and reflective. They do not defer to tutors.

As a researcher/tutor seeking to 'strengthen students' voices' I have sought to include in this thesis those issues introduced by students at the conference. The organisers saw themselves as researchers, and they gathered data which would be unavailable to me - both because my discursive positioning as tutor necessarily limits my access, and because the students asked different questions from mine. If we seek to strengthen students' voices, we need also to admit their questions into research on ABE. As Morwenna Griffiths puts it, we need not only to '[get] others' perspectives' but also to '[take] them seriously enough to be influenced by them' (Griffiths, 1998: 116). I could attempt to present students' findings 'as well as' (in some sense separately) from mine, but that would misrepresent the processes the students and I have shared: the students' research has changed my own, and our concerns are closely interlinked.

Some of the issues raised by students (for example, calculator use) are recorded in this chapter but are not taken forward to Chapter 11, which presents overall themes in the thesis. In this section, I summarise the themes which I take forward to Chapter 11. In parallel with that chapter, they are organised in three groups: methodological themes, students' and classroom perspectives, and wider themes. These themes all emerge from the conference, which was organised around students' questions; the themes are reframed here to fit my own 'take' on the overall research and the contribution made by the students' research.

5.1 Methodological themes: participant action research

The active, leading roles of students in the organisation of the conference gave access to data which otherwise would have been unavailable to me, including their views on the 'loud' voices of tutors and the need for tutors to accept responsibility for their own 'unsettling' (section 3.3.3 above). They were 'participant' researchers working in the same field as me but with different positionings and experience which I cannot share. In Chapter 2 I raised questions about the 'action' element of PAR. Here I suggest that the 'action' was not only the creation of an enjoyable and productive event; a key outcome was the critical analysis of practice in ABE maths education, in a context of building theory.

However, I have also raised questions about the recognition of students' work as 'research'. In Chapter 11 I go on to suggest that the question of *what counts as knowledge* hangs over the whole thesis.

5.2 Students' and classroom perspectives

The students absolutely reject any general statement of what a maths curriculum or pedagogy 'should' be; they recognise individual needs, interests, experiences and demands, and want a full range available from which to choose, in maths topics, contexts and strategies. We have seen that 'hard maths' (represented by tests, fractions and long division) is an important focus for maths biographies, calling up anxiety and panic but also determination and evidence of success and intelligence. That hard, often more abstract maths has practical application too and there is no consistent split between views of 'everyday' and academic maths. While dominant discourses of ABE suggest an 'everyday' numeracy curriculum, we have seen both that such limitations are not acceptable and that we do not have a shared language for talking about curriculum choices. As with other issues (for example, the use of calculators) the implication is that we need to explore ways of opening up these discussions with students.

The whole of the conference process depended on collective work, but the conference participants also speak for a demand for supportive group work in maths education itself, while recognising that some may prefer to work individually. Students identified learning to socialise and speak out (to family, employers, strangers) as one of the benefits of maths education; that demands a pedagogic approach which facilitates group work.

There were clear demands at the conference that the curriculum should be agreed with students, and we have seen that maths interests and preferred ways of learning are varied and students reject the imposition of standard curricula. Some routes towards negotiating the curriculum will be discussed in Chapter 11.

5.3 Wider themes

The students measure their success in maths education in terms of confidence, whether that arises from or is shown in formal test results, the ability to argue with their family or to 'just talk with anybody'. The whole conference showed students working with extraordinary confidence (including overcoming panic attacks - it was not easy), and I argue that the confidence came from positioning students as experts - people from whom maths educators could learn. In Chapter 11 I argue that both 'confidence' and meaning in maths are discursively constructed: they are not attributes of an individual or a maths problem, but are functions of the discourse.

A key issue throughout this thesis is the framing in 'critical' education discourses of tutors' leadership role in 'empowering' students (Chapter 2). I suggest that the conference and discussions around it challenge that perspective. In Ellsworth's terms, the conference shows student researchers both 'unsettling "difference"' and challenging tutors to 'unlearn positions of privilege' (Ellsworth, 1992: 115). I have argued that the 'text oriented' discourse (Fairclough, 1992b) of the conference was quite different from what my experience had led me to expect. Part of the evidence for the unsettling of 'difference' - in this case, the difference between students and tutors - comes from students' perception of a tutor as 'threatened' when students led discussions and took notes - that is, took some control. The conference gave opportunities for tutors to learn from students how they see our joint experiences, in terms both of tutor-student relationships and maths content.

My notes are full of my own (diminishing) anxieties as I 'shut up'. Those anxieties turned out to be unfounded, and indeed I have highlighted evidence pointing to the lack of transparency in students' and my earlier student-tutor discourses, whether spoken or written, from the history of maths to an agenda for a meeting; a more traditional dominance of the tutor voice does not lead to better communication. To gain access to students' expertise, experience and mutual support we need to make it possible for them to raise their voices.

One key element in strengthening students' voices is allowing students to work together, in groups, on their own agendas. I say 'allow' because it is clear that tutors are in a position to prevent it: many of the conference participants were astonished, as well as delighted, to have the opportunity to share experiences and opinions.

I have not attempted here to define what I mean by 'research', but to give a picture of the processes which the students and I called research. In Chapter 11 I draw on Stuart Hall's notion of 'metaphors of transformation' (Hall, 1993) to suggest that positioning 'basic' level students as researchers has a transformative effect in ABE discourses.

The next chapter discusses *Global Maths*, the magazine which had its origins in the Meeting for Maths Students for Beginners. I will end with comments on the conference:

> *I mean it was so interesting... really though, weren't it.* (Tracy)
>
> *Absolutely brilliant.* (Jeremy)

I really enjoyed the maths conference.	*(Lorraine)*
Everyone really enjoyed the meeting. Group all had something to say.	*(Sandra)*
The conversation was very interesting and intellectual. The opinions of others were very amazing and incredible. It was useful for both students and tutors to hear the valued ideas and opinions of other students from across the country.	*(Written comment by D. Bailey, V. A. Amankwaa, A. Turner, M. Richards)*
In all it was a great day.	*(Shazia)*

Chapter 10: *Global Maths*

1 Introduction

This chapter, on the writing practices and themes of the magazine *Global Maths* (Appendix 10), has as its context the notions of empowerment and voice discussed in Chapter 2, and continues the discussion of curricular and pedagogical issues raised through the *Meeting for Maths Students for Beginners* (Chapter 9). The chapter is largely descriptive, exploring the notion of 'the voice of the student' through examining both the practices behind the production of the text and the themes of the magazine, including curricular and pedagogical issues. The discussion of writing practices problematises any simple or unitary notion of 'voice'; and the themes discussion centres on issues of students' 'sameness' and 'difference', in a context of shifting the classroom discourse to make it more student-centred. Both discussions have implications for pedagogy and the negotiation of curricula.

Fairclough defines discourse practice as 'the production, distribution and consumption of a text' (Fairclough, 1995: 135). Although I do not use Fairclough's detailed analytic tools, my discussion is informed by the attention paid in critical discourse analysis to power relations surrounding texts and the sense that texts are never isolated, but constructed through and contributing to wider discourses. My aim is to problematise the notion of a unitary 'student voice' - whether that of an individual or of 'the typical student' - detached from the discursive contexts of the writing.

In Chapter 2 I outlined some of the developments in adult literacy and numeracy, including student meetings and the publication of students' writing, which informed the conference (Chapter 9) and the magazine. There is a direct link from adult literacy to *Global Maths:* the magazine was proposed by the student organisers of the meeting, almost all of whom attended literacy courses at centres which had produced student magazines. *Global Maths* is, I believe, the most substantial UK collection of ABE students' writing around maths. I argued in Chapter 9 that the conference was an example of participant action research (PAR); *Global Maths* can be read as disseminating some of that research, through reports from the conference. In analysing the writing in *Global Maths* I have drawn on all the articles in the magazine, and the writing practices and themes I shall discuss reflect all the data; however, I use examples not discussed elsewhere in the thesis (Chapters 4, 8 and 9 discuss material published in *Global Maths*).

This chapter is organised in six sections: the story of the production of the magazine ('what happened'); writing practices; themes in *Global Maths*; my own place in the magazine; the distribution and 'consumption' of the magazine; and summary and themes.

2 Producing the magazine

The eight organisers of the conference became the core of the magazine group. They wrote a letter to all conference participants and other students and tutors we knew inviting contributions, and then wrote again inviting people to join the editing and production work. A further four students came to the production workshop, so a total of twelve worked on editing and production. The writing came from reports from the students' meeting and from maths courses, and a few specially written pieces. Of the 28 writers in the magazine, 15 were not conference participants.

The production workshop was held at Bede Education Centre, where we had access to six computers in one room. I did most of the typing of the writing by non-organisers and took it on disk to the production workshop; the organisers did their own, at or before the workshop. They also decided on layout, order, illustrations, type size and font. The students who used the computers were all used to using spellcheck. The layout and paste up (each page was done separately) were almost completed in about two hours of concentrated work. Some of the 'collective' decisions were barely discussed because people were too busy to stop work and trusted each others' decisions. (This speed and efficiency in joint work recalls the organisation of the conference.) In the following week I met with five of the students and we finished off the layout. The articles fall broadly into five areas: reports from the students' meeting; personal maths histories; maths questions and problems, and comments on writing them; discussion of maths courses, maths learning and pedagogy; and examples and discussion of maths studies and investigations.

Global Maths is a students' magazine in the adult literacy tradition. The style of the magazine reflects its genre: in common with many literacy magazines, it is A4 size, with hand drawn and clipart illustrations, large print, line-breaking and a mix of typeface (chosen by writers or the production group). It is distributed as a photocopiable set, costing £2.50 and therefore affordable to education schemes on tight budgets. Sales are through word of mouth, conferences and personal contacts.

3 Writing practices

I use the term *writing practices* to mean the production of a written text, in the wider context of discourse (following Fairclough, 1992b). The final texts have resulted from a wide variety of practices, and the following six examples, followed by a wider discussion of intertextuality and framing, illustrate the range. Most of the writing in the magazine probably went through some combination of these techniques and strategies. The discussion of practices will unpack the apparent meanings of the words 'writing' and 'writer': the articles come from a complex history of interviews, discussion, scribing, using other texts, tapes and re-writing, from writers who represent only their own views or those of others, and from my own editing (as tutor or researcher) of others' texts.

3.1 Dictated notes to support the writing

Demetra (who had not attended the conference) wrote her article *Almost Half My Life Being Wasted* (pp. 26-28) specially for the magazine. She had difficulties with spelling and, more generally, with organising the time to write. She opted to dictate notes to me, after her maths class; I wrote them in pencil as she talked, erasing and amending them when it was clear I had misunderstood. Demetra wrote her article at home, using all the notes I had written but adding more ideas. As she wrote the article, she underlined the parts of my notes that she had covered. (Demetra's and my own experience of this use of the tutor as scribe comes from 'language experience' literacy work, e.g. Good, 1986)).

The effect of this is that the overall structure and shape are as dictated to me, but the detail is greatly changed and enriched. For example, my notes begin:

> *Just starting Greek - at two or three - slow in speaking. Had to call and point. When four, came to England. Had to start English and the teachers thought it was confusing. In the 60s they couldn't understand how to cope with people learning English. They used to think you were backward.*

Demetra added illustrations and by mentioning her mother gave the authority for her memories:

> *My Mother said to me. When i was three years old. I had too point at the tap, when i wanted a drink of water, or anything ealse. At the age of three I then begain to understand & to speak very little Greek. My Parents decided to come over to England when I was four. I can remember staying at home & playing with my dalls prams & things like that - I did not do a lot of talking becouse I was not taught to try, intead I was push in the corner & not been taught by my own family. I remember my primary school, when I couldn't even remember me doing a lot of talking at school, but just saying yes & no & also I had to have speech therapy as I also was suffering with stammering. I even got in trabble for trying to explain to the teacher that the girl pinch my rabber & the teacher panish me for talking & put me to stand in the green mentale bin, then came play time I was tease by the children in my classroom. it was awful because I coul'nt say anything to nobady but to go to the teacher & hung around her.*

Demetra continues by describing her parents and teacher agreeing to send her, against her will, to a special school. In the notes dictated to me, the fault in her schooling seems to be attributed to 'the 60s' - a general ignorance which might not be the fault of individuals. The effect of the detailing of her misery, in the second draft, is to remove any sense of forgiveness for the wrongs done to her. The dictated notes read

> *the teachers thought it was confusing.*

In the second draft Demetra directly confronts the conflict between her view and the teachers':

They thought it was confusing for them. But how about me?

Demetra made similarly transformative changes throughout her writing. The last few lines of my notes read:

> *Weight Watchers - queue - busy - have to use calculator ~~to~~ when selling goods. If it's just two things, do it on fingers. I don't want people to watch me do it on my fingers, like £3.95 and £4.95.*

In the second draft Demetra widens maths to a tool to enable her to run her own life, and contrast that with her earlier powerlessness. Note also that the last three sentences have standard spelling and punctuation; presumably Demetra involved a third writer in the process.

> *The figa^u^rs I usally use is £3.95 + £1.85 + £1.50 small little figers like that & it just slows me down. I don't wan't that any more. I just went to calculate quicker than just useing my figers & so on. I need planty more knowledge in me. I want to get on by without any diffculties or embarrassment. I also want to control financial affairs i.e.. Mortgage, Loans, Tax, VAT & even starting my own Business one day. I don't want to be taken for a ride any more as from now!*

Starting with dictation enabled Demetra to sort out the broad shape of her story, and it saved her time. She is put off writing by the time it takes her; the dictated notes gave her a lift and hers became the longest article.

I typed it, standardising spelling and punctuation, and Jeremy, a student organiser, worked with Demetra at the production workshop on headings and layout. (The rest of the articles all had spelling standardised at the production meeting, and other quotations will be from articles as published.)

3.2 Writing on demand: the collective voice

At the production workshop I suggested we needed an introduction for the magazine; the students who knew her nominated Shazia to write it. She was a comparatively confident writer, a conference and magazine organiser and was held in affection by other organisers. None of these reasons was given by the students but I imagine they explain Shazia's nomination. She went round the production group asking what they wanted including, wrote a draft and showed it to everyone present. It was agreed and went into the magazine without further alteration; the whole process took about an hour.

The Introduction is signed '*Shazia*, on behalf of the newsletter group'. There is no other mention of Shazia; she writes of 'We the students'. The only other named person is me, thanked for having the idea for a maths conference. Shazia identifies all decisions as collectively taken among the students:

> *We then decided the idea that we should take the maths conference further ... The students thought that it would be a good idea ... We have exchanged views ... We have made many friends ... We the students would like to take maths further ... We would like to thank everybody who supported us ...*

Though the writing was done by an individual it speaks for a collective and sets the ethos of the magazine.

3.3 Transcripts of students talking, edited by the tutor/researcher

The magazine has three quite different examples of writing created by editing a tape transcript: *Writing Maths Questions* by Sandra (pp. 15-16); *Students Talk About Maths* by Paulette and Cindy (pp. 31-33); and *Talking about Maths* (pp. 44-47).

Sandra wrote some maths questions (discussed in Chapter 8) and I interviewed her about the process of writing them. Paulette and Cindy interviewed each other, using questions I had proposed for them (Chapter 4). Alev, Dave, Frank, Joyce and Violet had a taped discussion as part of their maths course (my voice as tutor is included); this appears in *Global Maths* as *Talking about Maths.* All three tapes were transcribed in three forms: detailed transcription for my own purposes; a simplified version omitting pauses, repetitions and specialised symbols, for the speakers to check and amend; and an edited version, greatly cut and re-ordered, for use with other students as texts to start discussion around these topics. These 'students' text' versions were also approved by the speakers, and are the ones in the magazine.

Although every word used in these texts (bar headings) comes from the declared author's speech, the shape of the texts is strongly influenced by my editing. I included ideas that are potentially controversial, in order to produce texts which would engage and challenge readers. In the case of the group discussion (*Talking about Maths*), I included every student in the edited version, even though that changed the balance of speakers. The texts are visually a teacher's production, with big print and line breaking. More important than all these decisions is the basic judgement: that an interview transcript is *worthy* of becoming a text for others to read.

Talking about Maths has a particularly complicated history. The students had written reviews of the term's work, including fractions, decimals and percentages. They then read aloud and discussed each other's written comments, in a wide-ranging taped discussion, including discussion of whether they found the term reviews useful. The tape includes overlappings and interruptions, and some people speak much more than others. Then they read the transcript, authorised me to edit it and approved the final version. In its final appearance the piece speaks to unknown readers of *Global Maths* and addresses questions of study time, homework, challenge in terms of maths level, accessibility of classes for students who learn in different ways, and the use of writing, discussion and worksheets; there is no mention of fractions, because I wanted to be able to share the text with groups who might not be concerned with that particular topic.

None of the taped material was originally produced specifically for the magazine. The transcripts were produced for me to use in my research and the student or group to use as part of a process of reflection on their own learning; the 'student text' versions were produced for me to use with other students as part of the process of trying out research ideas from one group with others, and more generally to contribute to a bank of teaching materials to support group discussion. In this the texts are quite different from Demetra's or Shazia's pieces, for example.

3.4 Dictation to the tutor/researcher

The *Problems* by Jim and Owen (*Global Maths:* 29) were dictated to me as course tutor. They were written for an audience of the students' own class, rather than for the magazine. They were dictated because both Jim and Owen have difficulties with writing, and as students in literacy courses as well as maths they are used to giving dictation as a way to get their words onto paper. Some of the difficulties in this language experience process (Brown, 1985; Moss, 1995; Tomlin, 1998) are discussed in Chapter 8, where I identify the changes I made to Owen's dictated text.

3.5 Notes of discussions

The section *Notes and writing from the students' meeting* (pp. 4-10) is made up of reports from the small discussion groups at the students' conference (Chapter 9). Some of these writers took notes during their small group meetings; others do not have enough speed or public confidence to do that and did their writing later that day. Each piece then is by one named person but is intended to reflect the views of all the people in her or his discussion group.

3.6 Collating other writers' reports

The editorial/production group agreed when the magazine was first mooted that it needed one article that would summarise the findings of the students' meeting. Tracy agreed to take on this task, rather reluctantly, doubting whether she could do it adequately. At the conference the organisers had paired up to lead small group discussions, and one of Tracy's concerns was that she could represent the views of her own group but not others. She took the reports from the discussion groups and synthesised them. Her article, then, is based on those in the *Notes of Discussions* (above), and like them is intended to reflect the views of others, based on spoken discussions, but at a further remove than the first-stage reports. Like Shazia's *Introduction*, it is a response to a group request and represents collective views.

3.7 Intertextuality and framing: the meshing of spoken and written resources

We have seen that the texts in *Global Maths* have come from a range of practices, often invisible to the reader. I will now consider the effects of intertextuality (Fairclough, 1992b; Wallace, 1992) and writing frames. Intertextuality is an inevitable reflection of the impact of previous texts (here including spoken texts) on the writer, and is woven through the magazine. Fairclough (1992) defines it as the property of containing 'snatches' of other texts, which may be 'explicitly demarcated' or merged (p. 84). Other texts discussed here use a tutor-provided framework on which the student hangs the text.

ABE tutors, recognising that students may find it hard to start writing on a blank page, often provide a framework. This is challenged by Sean Taylor:

> *At one level this involves teachers putting words into students' mouths. At another level it involves 'framing' students' work for them. And at another level still, teachers obliquely tell students what to do, leading to ... students writing what they think the teacher wants. One way or another, this dilutes the students' sense of writing for themselves. (Taylor, 1995: 189)*

I recognise Taylor's critique, but would argue that (as we have seen above) few if any texts come from one, individual, uninfluenced mind, and frameworks may be useful for many despite the undoubted effect of incorporating the tutor's words into the student's 'voice'. Here I want to look at some examples of writing where though the 'snatches' or frames may not be 'explicitly demarcated' they are visible to me, and in some cases to fellow writers and perhaps to readers. Most of them arose from the writers' learning materials and home or classroom circumstances (those derived from Marilyn Frankenstein's textbook for adult maths learners (Frankenstein, 1989) are discussed in Chapter 8).

Several of the personal maths histories include snatches from the questions or writing frame used to start discussion and writing. Yvonne, Edna and Lorraine, for example, all quote more or less directly from their responses to starter questions. Yvonne's opening line is

> *I cannot remember who I learned numbers from, but I suppose it was from my mum. (p. 19)*

This is a response to the first question on a discussion sheet, 'Who first taught you numbers?', used in her class. The sheet also asked 'How did you feel stuck? What do you want to happen if you get stuck in this class?' These questions came from a similar sheet written by Joan O'Hagan, which I had used - so the writing reflects the personal networks of the tutors. Yvonne undermines the 'stuck' question:

> *It didn't make a lot of difference if I got stuck with my work at school, because I just took time off and by the time I went back they had gone on to something else (p. 20).*

Edna also addresses the 'stuck' question:

> *Whenever I got stuck the teacher was always very helpful. If I get stuck in this class I would like the teacher to re-explain things to me (p. 18).*

Lorraine's writing includes the sentence starters from the (different) sheet she used. Her article is called *You and Maths* - the title of the discussion sheet - and includes the questions and sentence starters from the original (again by Joan O'Hagan):

> *Maths makes me feel ... pleased when I can solve a problem ...*
> *Maths is ... working with numbers, measurements. (p. 23)*

Tracy used the same sheet but retitled it *My Maths History*:

> *Maths makes me feel ... Before, very scared. I would try to avoid it. But now I'm confident enough to have a go at it.*
> *Maths is ... Different. Useful, and can be fun (sometimes). (p. 25)*

Direct quotation leads to repetition in different articles and any reader of *Global Maths* could spot these similarities and speculate about their origin (and indeed Celia Rigg (1999) comments on the use of 'starter sentences'). Other influences are less overt. Yvonne's maths history (pp. 19-20) includes an open letter to her present teacher. This is at least in part in response to an idea I (as teacher) took from Frankenstein (1989), where the aim is to articulate anger against previous teachers. One student started his letter,

> *Dear Sir,*
> *You ruined my life...*

In contrast, Yvonne's letter (p. 20) starts off

> *Dear Maths teacher,*
> *I am writing to say thank you ...*

The same framework can then be used in quite different ways, but in either case, the debt to Frankenstein is hidden. Yvonne finishes her maths history with a quote from school reports which both illustrates her schooling history and finishes her article on an ironic note, enabling her to distance herself from the criticism:

> *All my school reports said "Yvonne is not at school often enough for me to make a comment." (p. 20)*

Sandra quoted discussions with her husband in her writing (Chapter 8). Violet gives a pointer to group discussion as a help in writing when she describes how she wrote her maths history:

> *Perhaps what one understand about the course,*
> *the other one can explain,*
> *and we help one another that way.*

Because when I wrote the history of maths,
after we finished I stop in there in the hall,
and that's how I wrote it,
and I think that's the best thing I have done. (pp. 44-5)

Whether Violet used other students' words, responded to their questions, or had her mind focused on the subject, she here acknowledges others' presence in her work. We cannot tell in what ways other texts are influenced by students' discussions, with each other or with people outside the world of maths education.

3.8 So who wrote what?

I hope I have conveyed some of the complexity of the practices behind the writing in *Global Maths.* There is no one 'typical' approach; people used a range of strategies, with and without support or hindrance both from texts and from people within and outside their maths groups. Some of the named authors held the pen as they wrote and some did not; some quote colleagues, friends and former teachers; some quote written texts. The tutor/researcher role is evident in some articles and disguised in others. Some of the articles point to the past in recording spoken discussions, but also to the future in being designed to generate and support discussions among readers. While all the articles 'give voice' to students, it is clear that even from one author the voice is not isolated. I now turn to the themes which run through *Global Maths.*

4 Global Maths themes

The over-riding impression from the magazine is that the students are 'the same but different', and that this is to be celebrated; this emerges both from the direct statements of the writers, and from my own reading of the articles. That *difference* between the writers means that other themes are harder to pin down. We cannot make many useful generalisations about their views of maths, pedagogy and ways of learning, though two over-riding themes will emerge from this discussion: students should be actively involved in the planning of their courses, and the opportunity to exchange experiences is valuable and productive. Here I outline eight themes from the magazine (sections 4.1 - 4.8), and then suggest implications for curriculum development and pedagogy (4.9).

4.1 'Share opinions, same or different'

A strong theme in *Global Maths*, particularly from the conference reports but also from the overall anthology, is that *sharing itself is valuable, and leads to support from the recognition both of common ground and of differences.*

This appears in the *Introduction* by Shazia:

> *The students thought it would be a good idea to expand this maths conference, because it was a great success. We had no idea that students from other colleges and also tutors would share opinions, same or different. We have exchanged views and are now aware that maths is good to talk about. We have made many friends from other Colleges, of all ages and different cultural backgrounds. (p. 1)*

The differences identified here are student/tutor, institutional base, age, cultural background, and by implication maths (the subject of the 'opinions, same or different'), but none of these prevents the 'warmth' between people. In Chapter 9 I discussed the sense of community running through the conference and its aftermath. Here I explore related evidence from other articles in *Global Maths.*

Differences between students are identified throughout *Global Maths*: place of upbringing, mother tongue, educational background, achievements in maths and age are all mentioned; there is a general sense that every writer is an individual.

Work in adult literacy has long included personal histories, and, since the 1980s, personal language histories (Harris & Savitzky, 1988; ILEA Afro-Caribbean Language and Literacy Project in Further and Adult Education, 1990). *Global Maths* has articles by nine students about their maths histories, and many others make some reference to prior maths experience. These accounts differ in focus. Formal educational experiences range from Frank, who has learning difficulties (p. 37) to Andrew, who 'enjoyed doing problems in Arithmetic, Algebra and Trigonometry, but not so much in Geometry which I found difficult' (p. 17). Andrew's listing of maths topics, and Edna who 'started learning maths in the 1930's' (p. 17), remind us of the wide age range which itself means people have had very different experiences of schooling. Yvonne writes almost entirely about her schooling (p. 20); Lorraine focuses on her employment history. Sandra and Demetra (pp. 22 and 26) write about personal histories of disruption and discrimination, and maths is comparatively insignificant in an overall account of being failed. Contexts for the use of maths skills, mentioned as either experienced or valued by students, include painting and decorating, accountancy, dealings with a building society, computer spreadsheets, calculators, graphical presentation of a day in a student's life, cleaning, Weight Watchers, measurement, binary maths in computing and social security benefits. The range is huge.

Common ground derives not only from the general concern with maths education and self improvement, but from the placing of this range of maths histories in an anthology - a collective representation of difference. The assumption is that students' experience is valuable and relevant to the study of maths. Individuals' experience is assumed to be unique and therefore interesting; but the accounts also identify the writers as one of a community of people studying maths. The stories contribute to an overall picture of what maths students are like; the picture is one of difference.

The differences suggest that any standard curriculum is unlikely to be appropriate. The implication if we seek to strengthen students' voices (and this is consistent with other parts of this research) is that students need space to share experiences and to explore possible curricula and ways of learning together. I will next discuss the 'same but different' theme in the students' discussions of their purposes in studying maths, and their views of mathematics; following that, I go on to their experiences of learning maths at school and as adults, and implications for curriculum organisation and pedagogy.

4.2 Students' purposes for maths study: 'There is no end to what you can learn'

Four main groups of reasons for studying mathematics emerge from *Global Maths*: helping children, personal development and challenging oneself, recovering from previous failure, and needs for maths in everyday life and work. These are by no means separate; they overlap, converge and occasionally conflict (particularly in the contradiction between helping children do homework and having time for their own).

All appear too often to quote them exhaustively. Here I give only samples to give some of the flavour of the magazine:

> *Most students said ... you need maths for everyday living to understand bank and building society statements, bus and train timetables, paying the rent, council tax, buy the food for the week, how to measure yourself when you buy clothes, to tell the time. (Jeremy, pp. 9-10)*

> *Maths is essential in our daily life. Improving my maths will enable me to have more confidence in myself. (Edna, p. 18)*

> *I now want to do my GCSEs to prove to myself I am not hopeless, which is what my teachers made me feel. (Yvonne, p. 20)*

> *I want to become an accountant, because I enjoy maths and working the formulas out. (Jeremy, p. 11)*

> *I had an interview for the Royal Mail ... I was very pleased I passed the tests, especially the Maths which was the most difficult of all ... I am taking the opportunity in taking Maths classes to highlight my skills. (Novlette, p. 50)*

> *I would like to improve my maths, i.e. fractions, division, also shapes and maths they use in the national curriculum so I can understand what my children are learning. (Lorraine, p. 23)*

> *I do know if I work very hard on the course that I can show everyone that I can make it on the course. I really do think it is very hard for someone with learning difficulties to pass at a very high level to get the certificate. (Frank, p. 37)*

It is difficult to quote these without falling into a trap of the common-sense discourse of adult basic education, which holds that students 'lack confidence'; this is cited in dominant discourses of ABE maths as a reason for an emphasis on individual programmes of work. I suggest that it would be an inaccurate interpretation of these students' accounts of their reasons for studying maths. Yvonne, for example, says she wants 'to prove to myself I am not hopeless'. That seems more to express courage than a lack of confidence - a belief in her ability to overcome earlier discouragement.

I would suggest these difficulties in ABE discourse arise from the attempt to generalise about adult basic education students.

I have listed four groups of reasons for returning to maths education. If we reconsider that list, there is a problem: what *other* reasons might there be for studying maths? (The only one I can think of is a view of maths as one of the humanities - a creative field of human life, which perhaps is implied in *Global Maths* though not explicitly stated.) I imagine professional mathematicians' reasons would fall into at least one of the groups. Of course students identify that they lack something - and the something they lack is maths. This returns us to the 'same but different' theme: they have in common the desire to study maths, and they differ in their experiences and purposes.

4.3 Students' views of mathematics: 'Maths is everywhere, wherever you go'

There is no one unified conception of what mathematics is or means. It has use value, both in everyday life and in employment prospects; it offers curiosities and puzzles; it is a source of considerable emotion, across a range encompassing anger, fear, pleasure and boredom.

Mathematics content is dominated by numbers, but there is interest in finding out what else it might involve. Shazia (from an initial perspective in which maths and numbers are synonymous) writes about patterning and visual aspects of maths:

> *To me it's like doing symmetry work. I think it's great to do work on symmetry and not thinking it's just maths. (p. 41)*

Lorraine completes the 'starter' phrase *Maths is* ... by simply putting 'working with numbers, measurements', but her history of maths includes her employment history, where she lists the maths involved in her various jobs (this extension of her writing will be discussed below). She sees maths in all aspects of her work.

Tracy puts *'Maths is ... different. Useful, and can be fun (sometimes*)' (p. 25). What is the *difference* here? Tracy could be saying maths for her now is different from school maths; or that maths is different from everyday life; or that it is varied and no simple answer is possible. We can assume at least that it is *interesting*. Jeremy is studying maths to qualify as an accountant, so he has an instrumental view of it; on the other hand, working out formulas is 'just like a puzzle' (p. 11).

Global Maths gives an impression of a group of people just starting out on a discovery of what might be included in maths. Their initial view of it seems to have been dominated by everyday contexts, involving numbers and measurement; their accounts of schooling generally give the impression that maths is a discipline in which exactness and the one right answer go hand in hand. Particular areas of the standard maths curriculum appear repeatedly, notably fractions (14 articles), decimals (four articles), percentages (five articles) and times tables and division (five articles), so there is no doubt that there is a demand for the traditional school curriculum. However, the students write now of interests in other cultures, other countries and different methods. Again then, there is no one dominant view of maths, but an openness and willingness to try out ideas: 'There is no end to what you can learn ... Maths is everywhere, wherever you go' (Tracy, pp. 8 - 9).

In Chapter 11, I explore further issues of students' epistemologies of maths. My point here is that students' engagement in the discussion of what maths is, or means, is productive and generates a wide range of perspectives.

4.4 Experiences of maths classrooms: humiliation, pace, pressure and competition.

In Chapter 9 I discussed students' ideas of a 'good' tutor. The personal maths histories in *Global Maths* give distressing examples of experiences of punitive classrooms:

> *If you could not do the work after being shown a few times, you were in for a taste of the teacher's belt. Things were so different then. You get very scared the moment it's time for Maths. (Joyce, p. 18)*
>
> *The teachers all the time would call me lazy, stupid. They would give me six of the best, or write lines, but most of all put me in a corner of the class and sometimes make me wear a hat with a D [for Dunce] on it. (Sandra, p. 21)*

Pressure from time and competition figure strongly in memories of maths classrooms:

> *At school ...there was one pupil who if he did not know how to solve a problem, he would willingly work with us, but if it happened the other way, heavens help us, because he would not help us. We all hated him for that. (Joyce, p. 19)*
>
> *My friend ... read out the [homework] answers. She only had a couple wrong yet she was called thick by some girls in the back row. Well that put me off... I panic when I'm left behind. I'm on question 4, everybody else is on 6. That's when I really panic. (Tracy, p. 25)*

Joyce felt some solidarity with others against the competitive boy. Others were isolated and felt themselves stigmatised (or physically punished); that fear itself removes the possibility of learning.

Most of the maths histories call up a world in which school mathematics is a stony desert, a place to be got through and survived, in which fellow students are either enemies or allies; a place where success depends on speed, accuracy and quick recall of facts. Tracy simply avoided engaging with it: 'I've dodged maths completely ... to get on without it' (p. 25).

In Chapter 9, I discussed students' views of what makes a good tutor, and their reactions to a tutor at the conference who 'intimidated' them. Shazia's account for *Global Maths* of interactions with tutors at the conference gives a different impression:

> *I'm glad that [workers from Bede, which Shazia attended] could make it to the conference, I felt comfortable. I did not know that there would be a load of tutors from the other parts would also attend the meeting, but I was ok with it. (p. 4)*

As we saw in Chapter 9, at the time she was not 'ok with it'. Tracy writes

> *When I knew there were tutors coming I started to panic but they listened to us and heard our ideas and thoughts. (p. 2)*

For the magazine, then, the students iron out the considerable difficulties in their relationship with one tutor. We should note however that the two unknown tutors at the conference became 'a load' to Shazia. Tutors *by dint of our role* have the power to make students panic.

Yvonne links her view of maths to her liking for her school teacher:

> *My maths teacher was about the only teacher I liked at school. Maybe that is why I enjoy maths. (p.19)*

When she responded with sarcasm to this teacher's comment on her frequent absences from school, 'he said he was sorry for upsetting me' (p. 20): this is a teacher who can respond to his students' affective responses to school education, that is, a teacher who can listen. Similarly Edna attributes her enjoyment of maths in part to her 'always very helpful' teacher. Such comments are consistent with views of 'good' teachers (Chapter 9) as listening, allowing a relaxed atmosphere and pace, and fostering a non-competitive discourse.

The sense of an isolated individual lost in the desert of school maths is one of the reasons cited for the emphasis in adult basic education on individual programmes of work; it is assumed that individual work removes the pressure of pace and competition. My own impression is that many numeracy tutors may share appalling experiences of school maths and seek not to inflict it on others. However, I would argue we should not (at least for all students, all of the time) accept that individual work is the only way forward. I go on to discuss pedagogical approaches which have made it possible for them to fight through their prior experiences and come to celebrate their achievements in maths. I draw together students' comments on ways of learning as adults: 'taking it seriously', support through group work, writing as a study tool, and 'listening' through materials based on students' writing.

4.5 'You must take it seriously'

Studying maths as an adult is a serious endeavour, even though it can be 'fun' and 'enjoyable'. It requires commitment. Some of the younger students compared their schooling ('fun') with adult college, where they would 'take their work seriously' (Shazia, p. 5). Paulette advises fellow students,

> *I think it's important to* keep coming
> *and not just come once every month or whatever.*
> *You miss out so much.*
> *You must take it seriously, and try to keep up with your studies,*
> *so you know you are always ahead,*
> *instead of feeling left behind. (p. 33)*

'Feeling left behind' is reminiscent of the problems of competitive schooling, above; here responsibility for keeping 'ahead' is placed on the students themselves.

Almost all the students in *Global Maths* attend a maths course for only two hours a week - 70 hours in a year. We have already seen Violet and Dave talking about the need to work together outside the class to consolidate new learning. The students are aware of the need for private study but for the parents, at least, this is difficult. Alev helps her children with their homework, but then is too tired for her own:

> *When I put them to bed,*
> *I just conk out on the settee.*
> *I open a book,*
> *and by the time I read it I'm just tired. (Alev, p. 45)*

Joyce agrees with her:

> *But then when the kids go to bed*
> *all I do is sit there, drinking tea and smoking*
> *and doing crosswords. (Joyce, p. 45)*

This does not absolve them of responsibility. Joyce blames herself ('I'm the one who's not pulling myself together', p. 45); Alev suggests going to the (public) library, 'Just sit in there and work quietly' (p. 45). We should note that none of these students has a library or quiet room at college, despite a clear need for a space in which students can work without tutors or children interrupting them.

4.6 Support through group work

Almost all the writing in *Global Maths* arose from group contexts. We have already seen that in the students' meeting and magazine practices an important theme is that of sharing and community while acknowledging individual differences. This is repeated in students' views of how they best learn maths. The solidarity of working in a group enables people to feel confidence and enjoyment in their learning; Paulette feels 'like you're in the winning *team*' (p. 32) and Cindy describes thinking "We're all in this together', and it is quite good fun' (p. 33). Others extend the idea of working together in the class to supporting each other outside the class:

> *One could team up*
> *after the end of the class,*
> *and then two or three people*
> *have to go through everything*
> *on their own free time. (Violet, p. 44)*

Dave agrees students should at the end of the class 'get together, and make sure everyone's understood what they've done' (p. 45). This notion of a group is not dependent on a teacher; indeed, Dave implies that within the class some people may not understand all the work and yet not approach the tutor about it. Antoinette records (p. 10) that students 'Like idea of a group': presumably some at the conference did not feel they were usually in a group (though all were in a 'class'). A group then is something involving team work, solidarity, mutual support and, crucially, no competition or pressure.

In attempts to shift the discourse of ABE maths so that it is less tutor-centric, a key idea is that tutors should 'listen' and 'hear'; that is, students invoke the notion of 'voice'. *Global Maths* reflects pedagogical approaches which contribute to such a shift in the discourse. We have seen students identify pressure, panic and anxiety as features of maths classrooms; identification of the issues goes a long way to easing the pressure. For example, two of the students (in different groups) left the classroom for a cup of tea when they felt panic setting in. Others in the group knew this, so it was not perceived as rejection or eccentricity.

> *The importance of the group process in validating personal experience and dismantling barriers of individual shame is crucial to the change process. The experience of success in maths enables students to question the self-concept of 'not being any good at maths', provides a needed contrast with past experience, and stimulates a search for more complex explanations of previous 'failures'. The process of ... looking more critically at patterns of success and failure in maths, identifying the subtleties of victim blaming and internalisation of failure, developing insights into the ways that myths and expectations shape our view of ourselves - each contributes to a rich terrain in which students can locate and make meaning of individual experience... We need to work with tracks already present as starting points for students to further explore their relationship with maths in the terrain of their total experience. (Webber, 1998: 21)*

Webber's argument for exploring personal experience in the context of group work recalls both women's liberation consciousness raising groups (to which I return in Chapter 11) and the adult literacy motto of 'starting where they're at', discussed in Chapter 2.

Some forms of group work allow students to form relationships that may support small group work and students' choice of peer support. Central to my meaning of 'group work' is the use of discussion, whether directly related to a mathematical text or to wider issues around maths (students' maths histories, or discussions about the curriculum). 'Discussion' in maths education is often treated as discussion of specific learning/teaching points, and this is important (Chapter 6). Here I am concerned with discussion where wider issues, particularly students' experience, classroom organisation, pedagogy and students' views of maths and the curriculum are included. This does not solve the problem of how to 'cover the range' of students' demands; however, it means that responsibility for directions taken by the group, including a critical stance on the teaching, lies with the students as well as the tutor. Students come to maths groups with a history behind them - often, but not necessarily, a history of being failed by the school system, and often too with a history of successful use of maths in their own lives. There may be other issues which while not directly maths-related impinge on their study (e.g. Sandra's dyslexia, pp. 21-2). Group discussion of those experiences gives a basis both for practical mutual support and for the creation of an appropriate course.

One pedagogical approach to starting such group discussion is through reading materials by students (a cyclical process, since writing often arises *from* group discussion, as we have seen), whether the writers are members of or outside the group, and I go on to discuss the use of writing as an individual study tool, and reading students' texts as a way of listening to students.

4.7 Writing as an individual study tool

Several of the students writing in *Global Maths* had worked with me on the question of whether writing within maths courses helps people learn, and this is reflected in some of the contributions. Paulette and Cindy discuss the value of keeping a maths diary (Chapter 4). One of its uses is 'like a memory thing', recording work done and aiding reflection on learning. Shazia makes a similar comment:

> *It is difficult to explain [Pascal's Triangle] in writing but at least when you've written it down, you could always look back at it and you'll know from your own way of thinking how to pick up where you've left off. People do tend to forget while they're working. (Shazia, p. 41)*

Dave too advocates writing down 'what you're not so good at' so that students can 'keep referring back to that work, and make it better' (p. 47). Joyce describes her difficulties if she has written only calculations and answers, without a commentary:

> *When I go home tonight [after the class] I sit there*
> *for about an hour and a half,*
> *and I sit and I think,*
> *how the hell I get these?*
> *I use the calculator to do some of them. (Joyce, p. 44)*

(This recalls comments on calculators in Chapter 9.)

A quite different view of writing is represented in Frank's article *Writing in Maths Classes* (p. 37). Writing during the class is an escape from the chatter of the group:

> *I do think writing really helps you to concentrate, with the rest of the students not saying nothing. It would be very hard if people are talking at the same time for the teacher to understand what the student in the classroom is saying. (Frank, p. 37)*

Although Frank's co-students take his point and acknowledge that 'people get preoccupied and start talking about different things' (Dave, p. 46), there is no doubt that here we have another example of difference. Frank wants quiet concentration and writing in the group; his co-students want discussion in the class, and writing to support individual work at home. We should note that this difference itself was identified through group discussion of ways of learning, and that the group responded to Frank's difficulties with too many people talking at once.

I described above some of the practices behind the production of texts. Some are derived from literacy teaching but are applicable, I would argue, in most adult teaching/learning contexts. All basic mathematics groups include, in my experience, students with technical difficulties in writing; my own practices were developed to support such students, but similar approaches are used in more academic writing (e.g. Shor & Freire, 1987: a written discussion between Shor and Freire). The student quotations above were about students writing for their own study purposes. But students' texts can also be used (with permission) as a basis for group (their own and other) discussion.

4.8 'Listening' and materials based on students' writing

We have seen that students value tutors who 'listen' and 'hear'. Reproducing students' texts for groups to share brings the texts into the formal discourse of the lesson and publicly values them. They give a focus for groups so that discussion can be extended (a similar argument was made in Chapter 6). For example, Lorraine's first draft of her maths history (pp. 23-4; also discussed in Chapter 8) finished at the end of her description of her education (end of para 9). Her group challenged this, saying work involved maths. Lorraine initially argued she had only done 'low level' work which needed no maths qualification, but the group asked her to describe her work history, interrupting with 'Well, that's maths then', and 'You ought to include that'; the ensuing discussion ranged over public images and personal experience of 'low level' work, and the skills needed. This discussion about what 'counts' as maths can then be taken to other groups, through their own reading of the text; it can also be re-read by the writer later in their course, to see whether they have changed their view of the meaning of maths, and can be used as a basis for discussion about the curriculum.

4.9 Implications for curriculum development and pedagogy

The differences identified in *Global Maths* suggest that to understand the 'needs' or demands of a group of adult students, we need to understand them individually. There are two currently dominant models for classroom organisation, leading to two ways of organising courses: individual work programmes, and whole class work. Although these are apparently pedagogical rather than curriculum models, they have implications for the curriculum.

Individual work programmes are 'tailored to students' needs' (indeed, the first literacy 'campaign' of the mid 1970s in Britain was built around a model of one-to-one teaching). This model is enshrined in assumptions in the FEFC funding arrangements and in much of the teaching literature and training. It denies the possibility of students' organising together to share experience, challenge tutors and learn from each other - all identified in *Global Maths* as important to the writers' learning. Tutors' control over both curriculum and teaching/learning styles is almost certainly greater when applied to isolated individuals.

Individual learning programmes, despite the apparent support of the FEFC, have nevertheless been undermined by increased class sizes and demands for 'accountability' expressed in accreditation of courses. Further, individual programmes place enormous pressure on tutors' preparation and marking time. These factors have led to a second common model of ABE provision: class work, leading to a certificate, with a core curriculum determined by the qualification. That curriculum is typically based around either standard, traditional arithmetic or the 'everyday maths' curriculum (discussed in Chapter 2).

It is clear from *Global Maths* that some students do want both standard arithmetic techniques and 'everyday maths' skills, and to dismiss these as limiting and/or domesticating is to deny students' own critical powers. However, to present them as a standard denies differences among students. *Any* standard curriculum cannot meet the range of possible learning interests. More helpful than the question 'What maths should we teach?' is 'How can we decide?' (Tomlin, 1999).

What then is a tutor to do? One of the difficulties is that there is so little ABE mathematics that students have almost no choice of course or tutor. We have classes which are mixed not only in terms of mathematics 'level' but in prior education, purposes of study and views of the meaning and uses of mathematics. Further, we have seen that new experiences in a mathematics course can dramatically change people's ideas of what mathematics is and what they want to study.

As with data from the conference, so here it is difficult to disentangle questions of content in the maths curriculum from pedagogical issues. A tutor who 'listens' is also one who is prepared to adapt the syllabus, her pedagogical approaches or both in response to what she hears. *Global Maths* suggests that the writers' views of themselves as maths students are dependent on their experiences, as child and adult, of maths classrooms. Their notions of what mathematics is, means or can lead to are closely tied to their experiences of pedagogy. Jo Boaler makes a similar comment on school students:

> *Students negotiated their identification with the pedagogical practices of the mathematics classroom and these practices could not be separated from their notions of 'mathematics'. (Boaler, 2000: 11)*

Similarly,

> *A learner's experience in the classroom frames the view she will have about the subject... The questions and prompts used, and the responses to these which are accepted, become the model of mathematical behaviour for the learner. (Watson & Mason, 1998: 34)*

Having said that no standard curriculum can be appropriate, there are nevertheless pointers in *Global Maths* to classroom organisation and pedagogical approaches which make space for students to express their own experiences and demands and which support a flexible curriculum. That space arises in the unsettling of the tutor-centric discourse of most adult maths courses. In Chapter 11 I return to the question of negotiating the curriculum.

There are no neat boundaries in *Global Maths* between students' views of pedagogy, the tutor role and ways of learning. Classroom discourse forms the web on which their suggestions are based. Experience of being failed leads to a focus on contrasting their school experience with their current maths courses; much of what we read is a call for an end to restrictive teaching approaches.

I turn next to a consideration of my own place in *Global Maths.*

5 Reading Global Maths: the influence of the tutor/researcher, and working in a research culture

My reading of the magazine, as someone who worked on it with the writers, is almost certainly quite different from that of a stranger. I know, for instance, that superficial measures such as length or coherence may not reflect the student's confidence or technical strengths as a writer. Intertextual features which may be disguised for other readers are visible to me. My reading of themes from the magazine is partly determined by my knowledge of individuals' learning materials; so, for example, there is an apparent shared interest in how to deal with being stuck, but I know that comes from my own interest in it which led me to ask the question.

My influence is considerable. I wrote earlier, for instance, that I edited some of the transcripts to make them accessible as learning materials if I thought them 'worthy.' My definition of 'worth' involves my own judgement that the text will have the potential to spark further discussions about ways of learning and using maths - that it will open avenues for other students, and indeed tutors, to consider.

The students' meeting and magazine were both organised as part of collaborating with me on this research project, and every part of the work I have done is reflected in parallel by the students. This chapter, for instance, is the equivalent of Tracy's article summarising the students' meeting findings; we both have read other people's writing and attempted to collate and summarise it, picking out key themes and discarding peripheral ones. *Global Maths*, then, represents some students' considered and worked through contribution to this research, both as a collective and as individuals.

I want to compare my influence on *Global Maths* to the authority relationships involved in my writing of an article (Tomlin, 1998). The article is based on a report of a workshop held at a *Research and Practice in Adult Literacy* conference. I was one of the organisers of the conference. In the article I quoted workshop participants and other texts from which I had gained ideas (intertextual 'snatches'). The article was then drastically (and excellently) edited (by Mary Wolfe and Julia Clarke), in consultation with me and leaving editorial control with me. What difference is there between the sources of my writing and that of the *Global Maths* writers, or between the influence of RaPAL members on my writing and my own on *Global Maths* articles? I am concerned that the perceived effects of my influence as (joint) editor and tutor may be exaggerated through the views in dominant discourses of the comparative writing skills and educational experience of ABE students and tutors.

Having discussed the production and themes of *Global Maths*, I now turn to its 'consumption' (Fairclough, 1995).

6 'Consumption' of *Global Maths*

The magazine has been sold, copyright free, to adult education organisations in the USA, Australia and the Netherlands; distributed free to participants and their colleges; and sold in England and Scotland, mainly through conferences and following a review in an ABE journal (Rigg, 1999). Five of the organisers and I together led a RaPAL workshop on the *Meeting for Maths Students for Beginners* and *Global Maths* (Gray et al., 1999), and three students and I have led seminars for tutor educators.

The magazine is seen by its writers as a tool to introduce change. In most cases we do not know how it is received; one story from Ghana illustrates how it can be used. Violet took copies with her when she returned to her home village on holiday. At a village meeting she told her story of her life in London and showed *Global Maths.* She argued that her village mathematics education had served her poorly, because it included no investigative work, and students were nervous of asking questions. Violet's London maths group included someone with learning difficulties, and her own daughter has multiple disabilities; she questioned the use of a standard curriculum as being unlikely to suit all students. She was delighted that she had been able to raise such issues, with a text around which she could base her arguments. However, Violet's point was that the village school could produce its own mathematics magazine. *Global Maths* is not a new textbook, a finished product, but a part of a process contributing to, and produced in, a more student-centred discourse.

7 Summary and themes

Here I summarise the themes from this chapter to be taken forward to Chapter 11. They are in two groups, reflecting those in Chapter 11: students' and classroom perspectives, and wider themes.

7.1 Students' and classroom themes

The students writing in *Global Maths* are not one homogeneous group. Their experiences, reasons for studying maths and preferred ways of learning are different, even among those who value working together.

The students' initial curriculum interests were often defined by the dominant maths education discourse, in terms of recovery from earlier 'failure', helping children with school maths or instrumental needs for maths qualifications. We have seen however that these views may expand when the discourse of the classroom shifts, and may include multicultural, investigative and/or historical maths. Students' understandings of what maths means are inseparable from their experiences of pedagogy.

An implication is that we cannot make many useful generalisations about students' views of maths, pedagogy and ways of learning. I shall argue in Chapter 11 that such generalisations, a prominent part of both official and critical maths education discourses, form the basis of dominant and critical views of appropriate curricula and are poorly based.

There are however two themes to draw out from students' views of curricular and pedagogical issues.

Firstly, students seek active involvement in the planning of their courses, including both curricular and pedagogical issues. Curriculum negotiation will be discussed in Chapter 11, building on suggestions derived from classroom practices including those discussed here.

Secondly, students value the opportunity to exchange experiences - to discover what the 'sameness' and 'differences' may be; they want to talk to each other. This is reflected in the magazine itself - a collective representation of different voices. Two interlinked types of discursive practice in the classroom provided the ground on which students could share experience and made space for students to hear each others' voices:

- group work, with discussion at its heart, was a base for the generation of the writing in *Global Maths*;
- such discussion was used to generate reading materials which include a range of student voices, and which are based on students' own accounts of their experiences rather than on the myth of the typical student. In turn the group's own work was used for that group and others to read and discuss.

Group work and the use of students' texts sidelined the tutor's voice, valued students' experience, and contributed to the development of further discussion materials. I don't want to present these as a sure-fire recipe for a discourse which values students' voices, but as strategies which may contribute to shifting classroom discourse when the tutor seeks to do so. We have seen that texts come from complex interweavings of individual and classroom discourses and that my own influence on *Global Maths* was considerable; nevertheless the impression from the magazine, and the processes that went into its production, was that students saw it as a means to make themselves heard and to listen to other students.

7.2 Wider themes

This chapter contributes to three of the wider themes to be discussed in Chapter 11.

7.2.1 'Everyday' and 'real' mathematics vs. academic maths.

In *Global Maths* we have seen students working on, discussing, celebrating and condemning maths and maths education in a huge range of contexts. This has implications for curriculum negotiation and design, as I have noted above, but also at a more general level. In Chapter 11 I argue that official, liberal and radical maths education discourses take for granted that maths education can broadly be divided into two sorts, 'real world' and academic, and that the former is appropriate for ABE students. I shall use evidence from *Global Maths* together with other episodes in the research to argue in Chapter 11 that this division is unhelpful and poorly based. To suppose tutors know the 'real world' of students is a further example of the generalisation we have seen students resisting.

7.2.2 Confidence and classroom discourse

We have seen that maths tutors by dint of our role have the power to make students panic. This reflects the combined force of the discourses of education (both past experiences of schooling, and present adult education) and the dominant discourse of maths education, with its competition, pace, pressure and the one right answer. Under these combined pressures, students are isolated at the same time as they are treated as a homogeneous group.

The question of confidence as a measure of success in maths (for students) and lack of confidence as an attribute of ABE students (in tutors' and official discourses) will be further explored in Chapter 11, where I argue that confidence depends on the students' discursive positionings and therefore the focus of our attention should be on unsettling classroom discourse rather than on 'giving' confidence to students.

7.2.3 Voice

I want to hang on to the notion of voice, even though I have argued that we must recognise the histories, cross-currents, influences and restrictions - the discursive contexts - behind the students' (or anybody's) writing practices. The evidence here suggests that 'voice' is not unitary; students' voices are not always in unison; but the endeavour to listen to students, and allow them space to hear and respond to each other, is celebrated in *Global Maths.* Central to students' ideas of a good tutor are that s/he should 'listen to' and 'hear' the students.

Munir Fasheh writes that maths

> *can be used to make one aware of the drawbacks in one's own culture and try to overcome them (Fasheh, 1997:(284)*

and proposes the development of a syllabus based on the relationship between maths and culture, to enable students

> *to understand themselves, their beliefs, and their culture better. They will also be able to understand other people and other cultures better. ... Most important, it will help, I hope, in fighting three of the biggest evils in our time: absolutism, intolerance, and ignorance. (ibid.: 289)*

Global Maths is a small contribution to ABE maths moving in this direction. The 'three evils' are challenged in portrayals of schooling. The magazine's title reflects the students' own perspective derived from the make-up of the group; the authors celebrated the international and multilingual make-up of participation in the conference and magazine. I cannot claim that

Global Maths of itself helps 'understanding culture', but I think it does help us recognise at least that maths is part of culture - socially produced and varied, and potentially creative, useful and challengeable. The writers celebrate the opportunity to learn about each other's different practices and experiences.

In *Global Maths* students analyse and illustrate their own experiences of education. They are, further, *organising*: coming together to develop ideas alongside joint strategies for change. They are engaged in 'praxis', the term for the union of theory and action used by Freire and others (Fasheh, 1991). We don't always have to agree with them; as with any other writer, politician, learner, teacher or mathematician we can engage in debate. *Global Maths* illustrates ways not of 'solving the problem' with a new standard curriculum, but opening up issues with students so that the explanations, solutions and compromises are not all those of the tutor (or government). The organisational and teaching practices discussed here support students working towards this openness, solidarity and individual presence.

Chapter 11: Themes and conclusion

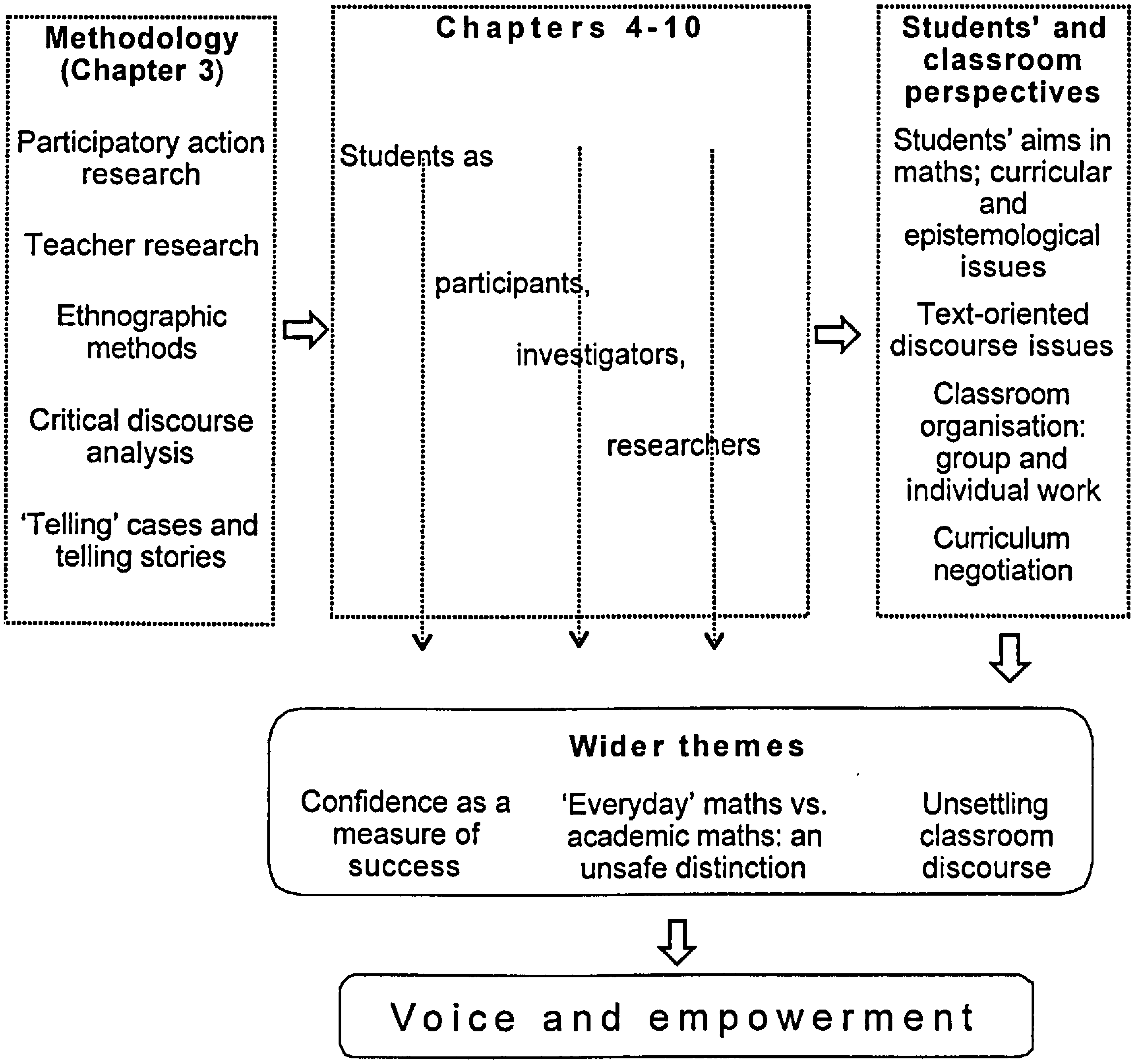
1 Introduction

My research questions (Chapter 2) were:

1. *What does 'radical' mean in adult numeracy work, for me, in Britain, now?*
2. *Does the research fit a Gramscian or Freirean model, and if so, how?*
3. *What and how can tutors 'negotiate' in a government-funded numeracy course? How does negotiating the curriculum have a bearing on voice and empowerment?*
4. *What is the action in this research? In what sense is this research participatory?*
5. *What do pedagogic practices from literacy bring to the numeracy classroom?*
6. *What is the connection between tutors' and students' epistemologies of maths and classroom practices? How does students' own maths experience fit into a negotiated curriculum and into dominant, 'standard' maths?*

These are complex questions to which I can attempt only partial answers. The research process has also generated, inevitably, unexpected and unplanned-for outcomes. This chapter is organised around the themes shown in the diagram on the next page.

The left-hand box reminds us of the methodology discussed in Chapter 3. The central Chapters (4-10), each based on an episode in the research, lead to discussions relating directly to classroom contexts; these are as much students' issues as mine, and are listed in the right-hand box. The lines weaving down are wider themes I have drawn from data, addressing my questions rather than students', but incorporating their issues. These threads are drawn together in addressing the questions relating to voice and empowerment which have been central throughout the thesis.



This concluding chapter has four main sections, organised around the themes. Each research question is addressed (and I draw attention to the questions in the text), but the themes form a more coherent structure:

Section 2: methodological themes
Section 3: students' and classroom perspectives
Section 4: wider themes
Section 5: voice and empowerment.

These are followed by a brief conclusion.

The following table shows the source chapters, where relevant, for themes discussed in this chapter, alongside the research questions.

Chapter 11, section ...	Source chapters	Research questions
2. Methodological issues	3	
2.1 Discourse analysis	4, 8	
2.2 Students as researchers	4, 5, 7, 9	Question 4
2.3 Participant action research	2, 4, 5, 7, 9	Question 4
3. Students' and classroom perspectives		
3.1 Students' aims in maths; curricular, epistemological and pedagogical issues		Question 6
3.1.1- 3.1.2 Tutors and students' epistemologies of maths, and classroom practices	4, 7, 9	
3.1.3- 3.1.4 Students' aims in maths	8, 9, 10	
3.2 Text-oriented discourse issues		
3.2.1 Multimodal communicative practices	5, 6, 7	
3.2.2 Reading and writing practices	4 - 10	
3.3 Classroom organisation: group and individual work	5, 6, 8, 9, 10	Question 4
3.4 Curriculum negotiation	2, 4, 5, 8, 10	Questions 3, 5 & 6
4 Wider themes		
4.1 Confidence as a measure of success	4, 8, 9, 10	
4.2 'Everyday' maths vs. academic maths: an unsafe distinction		Question 6
4.2.1 The 'real life' and 'academic maths distinction		
4.2.2 Word problems and 'real life'	8, 10	
4.2.3 'Meaningless' maths?	5, 6, 7	
4.2.4 'Real life' for students		
4.3 Unsettling classroom discourse		
4.3.1 Discourse analysis and tutors	4 - 10	
4.3.2 Discourse analysis and students	4, 5, 6, 7, 9	
5 Voice and empowerment		Questions 1 & 2
5.1 Voice		
5.1.1 Quietening the tutor	9	
5.1.2 Questioning the tutor's dominance	4, 5, 9	
5.1.3 Using students' texts	6, 8, 10	Question 5
5.1.4 Student-only discourse	4, 9	
5.1.5 'The same but different': students' voices	9, 10	
5.2 Empowerment		
5.3 Freire and Gramsci		
5.3.1 Freire		
5.3.2 Gramsci		
5.4 A metaphor of transformation: student researchers		
5.4.1 Consciousness raising		
6 Conclusion		

2 Methodological issues

The left-hand box in the diagram above reminds us of the methodology discussed in Chapter 3. Rather than revisiting that discussion, here I discuss three key methodological themes drawn from the research: the use of discourse analysis, working with students as researchers, and participant action research (PAR) - the last addressing question 4.

2.1 Discourse analysis

Questions of 'strengthening students' voice' and 'empowerment' demand a framing theory which examines the relationship between language and power. I am not making an ontological claim that adult basic education *is* 'a discourse', but that to think in terms of discourse analysis has been methodologically useful. Critical discourse analysis is centrally concerned with power relations; it addresses other aspects of communication as well as language; and it facilitates moves between detailed, small scale textual analysis and wider, more overtly political, considerations.

Fairclough defines critical discourse analysis (CDA) as aiming

> *to investigate how [discursive] practices, events and texts arise out of and are ideologically shaped by relations of power and struggles over power; and to explore how the opacity of these relationships between discourse and society is itself a factor securing power and hegemony. (Fairclough, 1995: 134)*

This thesis does not in any serious way address the second of Fairclough's aims, though his framing of discourse analysis in such terms, with the invocation of Gramsci in 'hegemony', makes it attractive to tutors from the background I described in Chapter 2. Because discourse is a form of social practice, it is constitutive as well as socially shaped, and changes in discourse (which I argue have developed through this project) are transformative.

I have not in the main used the tools of detailed textual analysis (cf. Fairclough, 1989: Chapter 5), though I have drawn on them occasionally. Rather, discourse analysis has informed my general approach to reading texts (both spoken and written), so that, for example, when coding transcripts I have looked not only for overt 'content' (for example, curricular and pedagogical demands, or particular ways of doing mathematical work) but also for indications of power relations, agency and experiential and relational values (Fairclough, 1989: 112).

Fairclough's conception of discourse is centred on language use but incorporates practices in other semiotic modes, for example non-verbal communication (Fairclough, 1989). The research discussed in this thesis has used data in many modes. These modes have been shown to be woven together: meanings are constituted, shifted, pulled in different ways in the meshing of practices (discussed below, section 2.4).

In Chapter 2, I argued that this research seeks to offer 'telling cases' (Mitchell, 1984) of the discourse and practices of adult basic maths education. Each episode, or case, is small in scale in terms of numbers of people involved and period of time. However, because discourse analysis seeks to unpack the practices behind the apparent texts - to 'explore the opacity' of relationships within and between discourses (Fairclough, 1995: 132) - apparently small pieces of data become rich sources for analysis. In Mitchell's terms, they are 'telling' rather than 'typical'.

This conceptual framework allows us to 'read' a student-written question, or any other piece of data, at a closely detailed level while placing our reading within an overall order of discourse. This does not of itself suggest any challenge to power relations. It does however allow us a means to relate, in the same analysis, the 'grand narratives' of power outside the classroom and the detail of relations inside the classroom . It's not that this is *new;* only that it allows us to recognise the links people make for themselves (for example, the tape made by Paulette and Cindy depends for both its force and its irony on their playing between the discourses of Jamaican radio, formal maths study and practical uses of maths in shopping, and their awareness of the relations among their audience of fellow students and tutor). It invites us too to investigate such links where they are apparently hidden (behind Sandra's apparent confidence in writing formal maths questions lay her history of dyslexia, corporal punishment and being failed by school).

Our understanding of what happens in the ABE maths classroom is unexamined, rudimentary and highly emotional. CDA offers a reasonably accessible, recognisable set of tools of inquiry (Gee, 1999) for tutors, students and researchers.

2.2 Students as researchers

The second key methodological strand is that of working with students as co-researchers. I will come back to this in the final section on empowerment and voice; here I want to group some of the immediate effects of the shifts in methodology which have run through the research, and link them to participant action research (PAR), a much-advocated research paradigm in adult education.

Students' central role in the research, as active inquirers rather than objects of study, introduced areas for research which otherwise would have been missed. Three examples illustrate this:

- I would not have undertaken Sandra's work on subtraction algorithms, since I didn't *see* the ones she looked at as five algorithms, but two, both already (I thought) familiar to me.
- Students found evidence for features of classroom discourse which, though I knew in general they were relevant, would have passed me by in the particular context - for example, the students' observation that I asked more questions of men than of women.
- At a wider level, Paulette and Cindy introduced for classroom consideration issues of pedagogical style which raised for me the dangers of assuming a pedagogical style necessarily implies something about the nature of maths.

2.3 Participant action research

My fourth research question was

What is the action in this research? In what sense is this research participatory?

In Chapter 2 I raised questions about the meanings of 'action' in PAR. This research fits within the field of PAR, and I have suggested (in Chapter 9) that the 'action' is the critical analysis of practice in adult maths education, in a context of building theory. The action and participation are meshed in the shifts in classroom and research discourse, further discussed below (section 3); participation in study of classroom discourse of itself changes it, that is, has an active effect.

I have now a new question around the third term of PAR: research. The question of *what counts as knowledge* hangs over this work. This thesis will count differently from both *Global Maths* and students' dissemination and continuation of their work by word of mouth. This is confirmed by a depressing experience. A student and I together went to a meeting organised by an FE college basic education department, led by staff from the Further Education Development Agency, on *FE teachers and students as researchers.* The title seemed to be there simply because it sounded good. Students were mentioned *only* as objects of study; we were advised that universities demand quantitative research; overhead transparencies used terms which were incomprehensible to the student (and probably some other participants), such as *ab initio*; and participants were not asked to contribute their own experience until the last 10 minutes. The discourse of the meeting suggested that what the student and I had together engaged in was not research.

> *The key to Discourses is "recognition." If you put language, action, interaction, values, beliefs, symbols, objects, tools, and places together in such a way that others* recognize *you as a particular type of who (identity) engaged in a particular type of what (activity) here and now, then you have pulled off a Discourse (and thereby continued it through history, if only for a while longer). (Gee, 1999: 18)*

The key issue then is whether students will be *recognised* as researchers. Gee writes that getting one of your Discourses recognised in another Discourse widens what 'counts' in that Discourse: 'You pushed the boundaries' (Gee, 1999: 21). Getting students' research recognised within ABE widens what counts within ABE, then; but we also need to widen what counts as research. Meanwhile, I must hope that the higher status accorded to this thesis than to students' own production is mitigated by its emphasis on the direct and transformative benefits of students' work as researchers.

Patti Lather, who describes her concept of 'research as praxis' as going beyond the action-research concept, writes:

> *There are ... few clear strategies for linking critical theory and empirical research. (Lather, 1986: 261)*

This research has attempted that link. One of Lather's proposals for research as praxis is that it should have catalytic validity, judged by:

> *the degree to which the research process reorients, refocuses, and energizes participants towards knowing reality in order to transform it. (op.cit.: 272)*

I would argue that the research processes reported in this thesis have been transformative and have high catalytic validity, if the 'reality' is the discourse of students' own classrooms.

3 Students' and classroom perspectives

I now turn to the themes in the right-hand box of the diagram. These relate directly to classroom contexts, but also contribute to the themes to follow in section 4. My starting perspectives (Chapter 2) included the overall aim of strengthening students' voices; a commitment from the outset of the research was to recount students' views.

3.1 Students' aims in maths: curricular and epistemological issues

3.1.1 What is the connection between tutors' and students' epistemologies of maths and classroom practices?

This is the first part of question 6. There is a paradox:

- Students' notions of what maths is, means or can lead to are closely tied to their experiences of pedagogy (including their school experiences); this is discussed in Chapter 10. This is similar to Jo Boaler's finding in a secondary school context:

  > *Students negotiated their identification with the pedagogical practices of the*

> *mathematics classroom and these practices could not be separated from their notions of 'mathematics.' (Boaler, 2000: 11)*

- I have argued (Chapter 4) that attempts to introduce a fallibilist (Ernest, 1991) epistemology of maths through pedagogical style are likely to fail. The tutor may have a view of maths as socially constructed and part of the weft and warp of dominant discourses; a critical perspective of this sort implies that students may be seen as both critical and creative and that maths will be presented as a source and tool for social and economic critique and change. But when we hope that somehow our pedagogy will carry for us a view of maths, we run the risk of failing.

So paradoxically, in the first example pedagogies and epistemologies are mutually constructive; in the second, they are not. It seems to me likely that the explanation for this lies in the power of dominant discourses of maths. Though a fallibilist, socially-constructed view of maths is gaining ground in maths education research, the dominant view of maths in public discourses is still 'absolutist' (Ernest, 1991).

3.1.2 Implications

If tutors want to raise questions about the epistemology of maths, we must do so explicitly. Students are unlikely to ask for discussions about it, exactly because the view of maths as a given, rigidly hierarchical, right-or-wrong, set of facts, rules and procedures is so naturalised; students have (generally) come to learn maths, not to question it. A parallel development in London adult literacy work in the 1980s was the explicit introduction of discussion about 'grammar' and standard English (ILEA Afro-Caribbean Language and Literacy Project in Further and Adult Education, 1990), the apparently fixed and extremely powerful focus of many students' literacy ambitions. Both discussions can be directed by tutors towards exposing the socially constructed, power-laden, historical and situated meanings of 'standard' numeracy and literacy - not with a view to arguing students 'should not' want access to those discourses, but in order to have more sense of controlling rather than being controlled by them.

I am not proposing that all ABE tutors become philosophers of maths, but that (if we seek to undermine the absolutist position at all) we need both to introduce alternative methods, strategies, number systems and so on, and also to say why we are doing so. It is not only because some 'other' approaches may, for particular students or problems, be easier or more efficient, but because we want to say maths is not just one fixed thing. When tutors are explicit, students may have more chance of arguing back; that is, it is not necessarily abuse of the tutor's role to introduce such topics even when they are neither in the official curriculum nor requested by students. Explicit clarification of tutors' discursive positioning is consistent with arguments below about unsettling classroom discourse.

3.1.3 Students' aims in maths

Here I outline findings which, along with the previous section, build towards my answer to the second part of question 6:

> *How does students' own maths experience fit into a negotiated curriculum and into dominant, 'standard' maths?*

The range of purposes for students' spending their free time on maths education is so wide as to encompass anything we can imagine. I identified (in Chapter 10) four main categories:

- helping their children
- pleasure and intellectual challenge
- practical and vocational (including achieving formal qualifications)
- recovery from previous failure.

Others might group these differently: for example, helping children could be seen as practical. Within the categories there are many differences. For example, a parent wanting to help a primary school child might be entirely confident in the maths they studied themselves, but want to understand new approaches in the schools, or on the other hand feel that they can't help their child because they themselves failed at school.

However we group those purposes for studying maths, the width of range has important implications for curriculum and pedagogy within particular course groups.

Even where a group finds a topic of common interest, purposes and preferred styles of study may be quite different. We have seen, for example, students defending the need to work on fractions with reference to the use of fractions in high street prices; others practised standard algorithms for fractions calculations which appear to have little connection to practical demands, but rather an internal interest which feeds students' curiosity. We have seen, too, that students may choose to combat past failure by working on topics which previously defeated them. We cannot tell from the work itself what meaning it may have for the student.

Students also differ in their preferred processes of learning and these differences may have been disguised by the presentation of data in this thesis. For every student whose words or work are quoted here, others are omitted. Some students want discussion and some don't. Some of the students who were active in the research project chose not to go to the *Meeting for Maths Students for Beginners.* Some wrote their own maths problems;

others rejected that idea. Some want to work on areas of maths in which they previously 'failed'; others want to avoid them.

So supposing a group finds a shared interest in particular maths topics, it is quite possible that this is of little help in planning the course because the students' 'take' on those topics may be diverse (or seem, from a tutor's perspective, contradictory). Further, students' demands and interests change as their experience changes, whether it be experience of the course itself, of informal exchanges with co-students or something altogether outside the course (like Margaret's removal, necessitating decisions about her electricity payments).

3.1.4 Implications: rejecting generalisations

These differences between students and changes in their experiences cast doubt on most generalisations about 'appropriate' developments within adult basic maths education.

A framing generalisation of this thesis is that we must be cautious in generalising. This is an important challenge to the dominant discourse of adult basic mathematics, where generalisations such as *Adults often want to work on practical numeracy* or *Students seek recognition of their skills through qualifications* are increasingly accepted as common sense. However, it is also a challenge to some of the Freirean-influenced writers, centred in a discourse in which tutors take a leadership role in designing a radical curriculum.

One implication of this is that no single set curriculum or accreditation scheme could meet the range of interest, demand and learning styles. Curriculum negotiation will be discussed in section 3.4.

3.2 Text-oriented discourse issues: the range of representation of maths work

The second of the themes directly relating to the classroom is focused more directly on text-oriented discourse (Fairclough, 1992b), particularly students' ways of expressing mathematical ideas. The wide range comes from a desire to communicate, and I shall argue this has implications for group work (section 3.3) and course negotiation (section 3.4). First, though, a reminder of the main findings. The discussion is in two parts: multi-modal (Kress, 2000) communicative practices, and reading and writing practices.

3.2.1 Multimodal communicative practices

We have seen students gesturing to communicate their ideas of shape and pattern; using tally sheets and other forms of standardised recording on pro formas; and using colour to highlight and differentiate diagrams and lines representing patterns. Students have explored each others' subtraction algorithms and 'new' empty number line techniques. Not reported in detail here, but included in the data, are students' maths history graphs, in which they represented their histories of maths (in and out of formal education) as line graphs.

We should note too the silences: though not noticeable in transcripts unless that is what we search for, students may be silent, apparently 'not contributing', for a range of reasons. Silence has communicative power: as a tutor or researcher, I found myself many times looking (usually anxiously) at someone, wondering what was in their mind (that is, the student's silence does communicate *something*, even though its interpretation is more than usually ambiguous). I suspect (from informal conversations with tutors) most tutors interpret silence to mean either the student does not understand what is being said, or is not interested. Either of these may be right; but the evidence of this research is that some (Priya in Chapter 5 or Samina in Chapter 6, for example) prefer other modes of communication, and that different 'takes' on how to express ideas can be discussed in the classroom.

3.2.2 Reading and writing practices

I next consider issues relating to writing and reading practices within this research. The central issue here is that writing has been found to be inseparable, in both reading/interpretation and production, from other modes of communication. As outlined in Chapter 1 (and reported in Appendix 1) the early part of this research specifically addressed such issues. Here I look at common themes arising from the processes of reading and producing texts - the practices behind the visible, or readable, text.

Letters, words and numbers, pinned down on a piece of paper, carry an assumption that somehow they are more considered, or even final, than spoken words: it is tempting to think of writing as a reliable means to help tutors understand a student's thinking, or to help students express their ideas (Appendix 1), but writing is no more a window into students' (or tutors') thinking than any other mode of communication.

Writers may choose to omit ideas they are prepared to discuss orally. For example, Paulette and Cindy omitted from their diaries perspectives on the classroom that they discussed with each other on tape, but wanted the tape transcript included in *Global Maths*. Spoken and written texts are used in complex ways to negotiate relationships between speakers/writers and audience. Examples of ways in which students have intertwined reading, discussion, reformulation, drafting and responding to texts are included in each of Chapters 4-10.

'Writing' is not separate from reading and discussion. We have seen students using a range of approaches to writing, some of them linked more or less directly, via dictation, note taking and taping, to speech. Writing is transformed as it is read, both literally as we insert and omit words, and given new readings as students fit what they read into their own understandings. In these processes students call on a range of discourses from in and outside the classroom, enriching the maths discussion by bringing to bear on it their own understandings, both mathematical and of their and their colleagues' histories. Literacy practices are social, in the sense of socially constructed and discursively framed, even when they are private and solitary (Barton, 1994; Fairclough, 1989; Gee, 1999; Street, 1984; Street, in press). Here, however, they are 'social' also in the sense of 'collective': formed as two or more people share, reconstruct and transform the meanings of texts together, in the process of trying to come to mutual understanding. The text, whether words, diagrams, visual patterns or numbers gives some common ground from which such explorations can start.

3.2.3 Implications

Although I argue writing does not offer a transparent window to some sort of truth, it is a central element of the classroom practices of ABE and has been important in this research. One of the arguments of this thesis is that typical discourses of the ABE maths classroom can be unsettled by returning students' work (whether discussion, writing, calculations, diagrams or sketches), in course planning, studying maths and course evaluation, to both the writers and other students as a basis for further development and sharing experience. I return to this point in sections 3.3 and 3.4 below.

3.3 Classroom organisation: group and individual work

Most, perhaps all, of the work by students discussed in this thesis has been supported by group contexts. We have seen much apparently individual work (Sandra's subtraction algorithms work in Chapter 7, for example, or most of the contributions to *Global Maths*). However, the purposes for individual work are intimately associated with group contexts - so for example questions written by individuals were solved in groups; Paulette asked her group to listen to her taped interview; many of the *Global Maths* articles were written in group contexts or after reading others' work.

The value of group work is attested by students, and in Chapter 9 we saw the pleasure students had from meeting a broader group of their colleagues at the students' conference. Group work is social in two senses. Firstly, it is companionable (as the students' conference and many student class records showed) and mitigates against the humiliation of some students' previous experiences of maths education. Secondly, it generates collectively produced meanings - whether that is at the level of detailed maths work (Chapters 6 & 8) or discussion of classroom discourse (Chapter 5).

Individual work is still a very common form of ABE maths classroom organisation (perhaps the most common, though I know of no research on this). The draft Adult Basic Skills Curriculum now lists 'encouraging group work' as a way of 'reducing maths anxiety' (DfEE and Basic Skills Agency, 2000: 187); I have however just quoted *all* it has to say on the subject. There is no advice on how to organise group work, what might distinguish a 'group' from a 'class', or why it may reduce anxiety.

I shall argue (section 4.1) that lack of confidence is an attribute of the discourse in which the student is placed (rather than of the student her/himself); it is unsettling that discourse that may help 'reduce anxiety' (to use the DfEE's terms). Students and tutor together develop ways of understanding each others' particular discourses through *continuing* group discussion.

The DfEE asks us to

> *Make sure that learners are familiar with different ways of saying the same thing, for example, ... add, plus, the sum of, total, more than... Encourage learners to use mathematical vocabulary, but make sure that they understand everyday language used in a mathematical context. (DfEE and Basic Skills Agency, 2000: 188)*

They offer no suggestion as to *how* to do this, and we have seen (particularly in Chapters 6 and 7) how difficult, as well as productive, it can be to reach (apparently) shared understandings for words used in maths. Group work is at the heart of developing shared language for discussing maths, and creating an environment in which people can both contribute and learn from others. Students' use of a range of communicative practices (section 3.2 above) comes from their desire to share ideas with members of their group.

Here I list some pedagogical practices which have been found in this research to support group work:

- recognising that some students may want to avoid group work, and/or not share personal experience, we must ensure students have a right to privacy; if that is made explicit in the classroom, students are less at risk of being identified as 'loners' or 'not really there' by students and tutor (Chapter 5)

- students writing their own maths problems, whether 'straight' calculations, word problems or extensions to investigations, seems to lead to more joint approaches to problem solving than textbook questions (Chapter 8)

- investigative work, whether 'an investigation' (Chapter 6) or work conducted in an inquiring, critical, open-ended way fosters group discussion
- individual, private work can be shared, generating discussion around it.

These practices have some overlaps with suggestions in the next section, on curriculum negotiation.

3.4 Curriculum negotiation

This section responds to my research questions relating to curriculum negotiation (3 and the second part of 6):

> *What and how can tutors 'negotiate' in a government-funded numeracy course? How does negotiating the curriculum have a bearing on voice and empowerment?*
>
> *How does students' own maths experience fit into a negotiated curriculum and into dominant, 'standard' maths?*

It also addresses question 5

> *What do pedagogic practices from literacy bring to the numeracy curriculum?*

since some of the approaches I shall discuss - for example, sharing students' texts - are drawn from adult literacy education.

In sections 3.1-3.3 I have argued that students' mathematical aims, experiences and preferred ways of working, even among a comparatively small group, are enormously varied. What then should tutors (or colleges, or the government) be offering? The draft Adult Basic Skills Curriculum says,

> *What is different [from children] is the* contexts *in which adults use [basic] skills and the widely differing past experiences that they bring to their learning... Each individual learner will come with their own set of priorities and requirements, and these must be the starting point of their learning programme development. (DfEE and Basic Skills Agency, 2000: 13)*

They then describe a process of assessment and learning plan development in which 'the learner' is always singular.

The dominant, liberal discourse of adult education holds that the curriculum is *negotiated*, whether that is with a group or with individuals (Chapter 2). A typical response to this range of demand is to offer individual programmes of work. Although all the students who took part in this research did some individual work (as homework or during class time), and all had individual learning plans (as required by the FEFC among others), group work was an essential home ground for the development of the kinds of shifts in classroom discourse discussed here, offering a basis for the notion of 'negotiation' to have any meaning.

There is a dearth of published work on this. The curriculum is commonly negotiated in terms of topics and levels, not teaching styles, lesson plans or group organisation. There is a gap at the heart of the negotiation: the negotiation is on content, not process, and on the maths, not the discourse. They are not separate, but dominant discourses of maths education hold that they are. This in turn means that theorising about maths education is done by teachers, not learners. Students' voice as critical participants in the negotiation and development not only of the content but of the processes of their course (that is, the discourse) is important not only for them (so not only to 'give them more confidence') but because it changes the tutor's positioning too. We have seen, for example, changes in my teaching practices resulting from students' comments on classroom discourse (Chapters 4 & 5).

The students are not usually a unified group at the start of a course, and may never become one. They have heterogeneous experiences and interests, and may have little experience of each others' styles of debate. So as well as having the authority of the institution and her/his greater experience of adult education on the side of the tutor, there may be some disarray on the side of the students. They are probably not, in fact, a 'side' - they are a collection of individuals. Whatever the course design, it is likely that it will need to make space for both group work, to offer the opportunity of solidarity and group discussion, and individual work to allow for the differences in interests.

The discourse of negotiations between tutor and students is complicated, subtle and difficult. The tutor's dominant position means it is her/his responsibility to make it possible for students to know each others' positions - to know the bases from which people are arguing, whether that is their view of maths or of why there should be a tea break. This is a 'no win' problem: it is probably impossible to organise a course that suits everyone. Nevertheless, in this research there were particular discursive practices which made space for students to develop and share critical and productive perspectives on the discourse of their own class, on the discourse of standard mathematics and on particular course demands, and those practices themselves contribute to a shift in the classroom discourse. Examples include:

- written or spoken personal maths histories are a means for students to come to know relevant parts of their colleagues' histories and aspirations (Chapter 10)
- students' discussion about their class without a tutor there, later shared with the class and tutor (Chapter 4)
- taping a discussion about class practices, and then sharing the transcript within the group (Chapter 10)

- use of students' comments as a basis for starting discussion in a different group (several of the texts reproduced in *Global Maths* were used in this way, and indeed the magazine itself may now be in use as a way to raise debate in classrooms unknown to the authors)
- students' initial requests for topics and later course reviews can be shared with the whole group, so that students know what is held in common and where there are contradictions to be managed. (Appendix 11 is an example of a sheet showing contrasting views.)

Implications

This list above is not offered as an algorithm for how to plan the perfect, democratic, student-centred class. The practices do however have in common organising principles which are applicable, I argue, in any adult basic education class: making opportunities for students to express critical views, recording them in some way (written or drawn texts, tape recorders, notes taken by the tutor or students), and *returning* them to the group for reconsideration and development. One of my research questions was *What do pedagogic practices from literacy bring to the numeracy classroom?* One answer, I suggest, is the use of students' texts as resources for group discussion.

These suggestions all depend on at least some time being spent on group activity (though that doesn't mean every person has to participate; such non-participation itself becomes a legitimate subject of inquiry and may lead to greater understanding within the group), and on space being available for individual expression and dissent. Such open discussions mean that the minefield of balancing of group- and individual-focused work becomes a shared problem rather than the tutor's and thence (if the tutor gets it wrong) individual students'.

Developing such a discourse in the group is not a magical, sudden achievement - indeed, it will *never* be 'achieved' since the authority of the tutor is both institutionally given and sought by the students, and the dominant discourse of standard maths will not crumble before the onslaught of eight basic maths students and a well-intentioned tutor. If, however, we seek to develop a critical function for basic maths classes and challenge the dominant discourse of maths education, then such practices are openings and points of contestation.

4 Wider themes

I next consider the three themes I have drawn from the 'downwards' threads in the diagram - those which run across the chapters. I start with 'confidence' as a measure of success, and go on to the distinction between 'everyday' and academic maths. These two themes address what is, oddly, common ground in the dominant (government-led) and critical discourses of maths education: constructions of ABE students and of what is deemed an appropriate curriculum for them. I then turn to the theme of unsettling classroom discourse, which has run through the whole thesis, before more directly considering questions of voice and empowerment.

4.1 Confidence as a measure of success

This thesis has not focused on theories or evidence of learning; on the other hand, it has given some students' views of discursive practices which prevent learning. Their more usual experience of maths education has led to the humiliation reported in Chapter 10. The evidence in this research suggests that students measure their progress in terms of confidence, rather than skills or 'level' of maths work. Here I build on Chapters 4, 9 and 10, where I argued that confidence is a function of discursive positioning, not a fixed attribute, or lack, in individuals. This is not to deny that students gain in confidence from success in terms of maths education. Success in maths terms leads at least some to see themselves as 'cleverer'. But the classes leading to increased confidence are those in which students have been investigators, planners and researchers - sites of the 'unsettled discourse' to be discussed below.

The superficial implication of this is that since students measure progress in terms of confidence, tutors should do so too. In the 1970s and '80s there was discussion in adult literacy education about confidence as a measure of success (Charnley & Jones, 1981; Mace, 1992) but I have found no equivalent body of work on measuring confidence in adult numeracy education.

I suggest that for tutors there are two central problems here. Firstly, the dominant discourse of adult education sits easily with the suggestion that students 'lack confidence'. If people give up time to attend classes it is reasonable to suppose they are seeking more confidence *in some area of mathematics* - but the effect of stating that someone lacks confidence is to render it a characteristic of the whole person. This in turn is consistent with identifying students as other than 'us', needing special and, I argue, patronising treatment. Students' supposed lack of confidence is also at the centre of Freirean discourses of education, consistent with their need for empowerment and their 'culture of silence'. This will be discussed below.

Students who took part in the research did report areas in which they, or others whose opinions they sought, felt unconfident. However, those areas were usually related to discourses in which success in maths is central. We have, for example, seen students arguing that a tutor at the *Meeting for Maths Students for Beginners* was intimidating. This is a reflexive relation: students are constructed as unconfident in the discourses of education; their 'lack of confidence' in maths classrooms confirms for those of us in authority that students lack confidence.

The second central problem with identifying 'confidence' as a marker of progress is that it tells us little about what tutors should do. If passing an exam is a marker of progress, then we can teach to the test; but what is the equivalent for how to 'give confidence'? We have seen that Cindy, for example, didn't experience what I, her tutor, thought was encouragement as anything of the sort.

The implication of this is that we need to consider maths classrooms themselves as sources of silencing and sites of discursive shifts. The 'problem' of lack of confidence lies not with the student, but with the classroom discourse in which the tutor has the dominant voice and therefore the responsibility for unsettling discursive patterns.

The confidence demonstrated by the students who took part in the research has come from their experience not as recipients of some form of confidence imparted by a tutor, but as researchers into their own learning - that is, as intellectuals, rather than as people lacking intellect. The tutor's role is central in enabling this shift to happen, or at least to start to happen. But making it possible for students to feel in control is not the same as a 'giving' of confidence, where the tutors are the agents of action.

As I started to write this thesis I asked Sandra, one of the active participants, what she thought of my idea that confidence comes from where students are positioned in a discourse. She smiled and reminded me of her first maths class with me, when I explained the research project and asked if students would consider being co-researchers. She said,

> *When you said that word [researchers] we knew there wasn't authority in that room.*

Positioning students and tutor together as researchers removed, for Sandra, the authority of the teacher. The metaphor of transformation (Hall, 1993) of students as researchers is discussed below.

4.2 'Everyday' maths vs. academic maths: an unsafe distinction.

4.2.1 The 'real life' and 'academic' maths distinction.

Here I develop further discussions in Chapters 5, 6 and 8. We have seen above that students want a wide range of maths to be available; here I broaden the discussion to challenge the basis of the 'everyday' and 'academic' distinction.

Dominant discourses of adult basic mathematics education are built on an assumption that adult basic maths students 'need' or can best learn maths through a curriculum directly relevant to their 'everyday lives' or 'the real world'. The 'everyday' may be individual and personal (so the BSA has promoted a curriculum largely tied to students' domestic or work needs) or society/citizenship orientated:

> *[Mathematics] is about understanding the significance of number within ... our society. It is not about getting the right answer in a sum but about understanding how operations on data can clarify or obscure reality. It is not about meaningless processes applied to made-up problems but about how awareness of statistical techniques allows the learner to acquire a greater understanding of social issues and critically question public policies. (Benn, 1997a: 81)*

Benn's use of 'meaningless' here resonates with many students' memories of 'pages of boring sums' in their past maths education, but we need to explore it further. Her 'understanding of social issues', from a liberal perspective, accords with strands in critical maths education (for example, Frankenstein & Powell, 1994; Powell & Frankenstein, 1997).

I shall argue that meaning in maths comes from discursive positionings rather than residing in the maths, or a given 'context' for the application of maths. Jeff Evans makes a similar argument in his discussion of 'translation' (which he prefers to 'transfer') of mathematical skills from one discourse to another (Evans, 2000a; Evans, 2000b). However, his starting point is the question:

> *How should we teach mathematics so as to support adults' functioning satisfactorily in their work and everyday lives? (Evans, 2000a: 289)*

The question takes for granted that adults' purposes in learning maths are to support their work and 'everyday' lives, and that there is a given boundary between real life and academic discourses. I seek to challenge those assumptions.

Overtly critical curricula are in some ways opposed to the BSA-type domestic or vocational curriculum. The former seek to empower students in society; the latter, to help them fit in. However, all are based in a categorisation of the world of maths into academic and 'real life', with an assumption that only 'real life' is important for basic education students. I argue that this basic categorisation is unhelpful and that the foundation for the distinction between 'real life' (associated in overlapping discourses with 'the everyday', 'the familiar' and 'socially based') and academic maths is unsafe.

It is not only a question of student or tutor preferences, or practical organisational issues. 'Meaning' comes from discourse, so whether the solution to a problem ('made-up' or not) has meaning for the solver is not necessarily within the tutor's knowledge or gift. I will remind us first of evidence relating to word problems and 'real life', and then 'meaningless' maths, as a basis for arguing that we cannot generalise about 'real life' on behalf of students.

4.2.2 Word problems and 'real life'

Word problems are one (perhaps the) traditional way to relate learners' mathematical skills to questions from the 'real world'.

Word problems are a widely recognised trigger for panic, anxiety and failure, and the fear felt by students in this research was a fear not of the mathematical operations but of their discoursal framing. Even supposing word problems carried bite-sized (sum-sized) pieces of the 'real world', the fear they generate (in the ways students usually encounter them) surely limits their usefulness. They do not, however, succeed in their overt function of representing the 'real world'. We saw a beautifully-crafted example of the genre (by Tanya) which related to students' lives (a telephone box queue) and was mathematically and linguistically coherent, but nonsensical. Other student-written problems did not fit the genre so closely, exactly because they were closer to the real world, in that they lacked information or relied on approximations. However well-written, word problems cannot be a vehicle to carry the 'real world' or 'everyday life' into the classroom.

This is not an argument against using word problems: tutors and examiners will always attempt to offer plausible contexts for the practice and demonstration of maths skills, and to bridge the gap between complex real world problems and mathematical symbols. Word problems are part of the discourse of standard maths; I suggest when the purposes and discursive framing of word problems are open for discussion in the classroom, rather than taken for granted, classroom discourse is changed and students have ways into word problems.

Students' writing their own problems in this research helped them get 'inside' the dominant discourse, so they felt more in control. In an analogous move, real problems already solved by students outside the classroom were brought in for group discussion. (This does not preclude bringing in real problems for which students still seek solutions.) Such moves serve two purposes. Firstly, they problematise the relationship of 'maths' and 'real life' - that is, they allow a relationship which is already deeply problematical in students' experience to be discussed and shared in the classroom, and open up critical discussion of the uses of maths. Secondly, they promote students' conscious identification and sharing of their mathematical skills, thus 'building on students' strengths' (to use a motto from literacy) and using experience from outside to support confidence inside the maths classroom, that is, the discourse which is critical in the construction of students' 'lack of confidence'.

4.2.3 'Meaningless' maths?

I turn now to evidence from students' work on apparently 'meaningless' (academic) maths.

Apparently empty mathematical structures and processes have been invested with meaning by the students' engagement with them. Work on Pascal's triangle, for example, which could be applied to 'real life' (for instance, probability) but was treated as a 'pattern', became a vehicle for intellectual and aesthetic creativity. Students commented on mathematical structures; on problem solving approaches, and on something more akin to art:

> *I think there's more observation than adding up. ... I think it's great to do work on symmetry and not thinking it's just maths. I still need more practice ... colouring in [so] my patterns stand out more clearly.* (*Shazia, Global Maths: 41*)

Although word problems purport to bridge the maths classroom and the real world, some of those written by students were (like many in textbooks) 'meaningless' in Benn's terms. For example, at least one of the answers to how to divide a chocolate bar, $3^1/_2$ / 14, could be described as obscure. Nonetheless the students committed themselves to finding solutions. The commitment came from the context of production and solution of the problems: written by students, they contained (accidentally, in some cases) difficult maths, such that the writers found they did not know how to find solutions (that is, they were real problems), and the solvers were curious to find solutions but also wanted to support their colleague writers. Solutions were found through group discussion. The same problems printed in a textbook and tackled as homework would generate quite different responses.

For the last example I return to the group work on the 100 grid. Out of that the students created a new 'reality', in which lines, columns, numbers and their own hand-drawn connecting lines are agents, acting and creating new objects ('bench' and 'tunnel maze'). The reality was internal to the mathematical structures, but not the less real for that.

I argue then that the meaning of maths work comes from the discourses around it rather than only the overt content. Those discursive contexts are endlessly complicated and are generated through the interactions of students and tutors and their discursive positionings and practices.

4.2.4 'Real life' for students

The distinction between 'real life' or 'everyday' maths and academic maths is one made across a range of discourses of maths education by tutors, policy makers, researchers, examiners and so on with an assumption that we know what is 'real life' for students. This is a well-intentioned move, and it is clear that all the students in the research have bitter prior experience of maths education they describe as meaningless. Even that, however, has meaning at the level of students' responses, whether they are determined to go back over topics in which they were failed or determined to avoid them.

We have seen that students' purposes in study vary enormously; their experiences and contexts vary; and therefore so do the discourses of their classrooms (assuming that the tutor's leading role cannot entirely override what the students bring with them). It is this combination of discourses (the 'order' of discourse: Fairclough, 1995; New London Group, 1996) that determines what is meaningful in the classroom.

I would support Jean Lave's suggestion that rather than looking to a distinction between 'everyday' and 'theoretical' maths, we should focus on the distinction

> *between things (real and imaginary) that do and do not engage learners' intentions and attention, and give meaning to the activity they are engaged in and definition to 'what's going on here, what am I doing now?' (Lave, 1992: 88)*

This is then another argument against generalising - in this case, generalising about what is 'real life'. The 'reality' cannot be defined by the tutor or policy-maker on behalf of an idealised student, whether that student is constructed as worker, voter, parent or potential political activist.

4.3 Unsettling classroom discourse

I turn now to the notion of 'unsettling' classroom discourse (Ellsworth, 1992), a term I have used to name the changes which arise when students are active investigators and researchers. As the research developed and my own views and experience changed, students took more active roles. My argument throughout has been that positioning students as researchers undermines the dominant positioning of students as under-confident, 'basic', inexperienced learners, and enables students to use their knowledge, skills and confidence from discourses beyond the classroom. Students have inquired into discursive patterns at levels ranging from the minutiae of maths techniques (Chapter 7) to their own classroom (Chapter 5) and a wider view of basic maths education for adults (Chapter 9).

The relation is reflexive: strengthening students' voices involves unsettling classroom discourse, including the tutor's voice; and unsettling the discourse makes space for students' voices to be heard. In the final section, I take up the 'metaphor of transformation' (Hall, 1993) of students positioned as researchers. Here I suggest that fruitful 'unsettled' classrooms could be fostered through the development of three discourses in the classroom, for tutors and students.

4.3.1 Discourse analysis and tutors

Firstly, *for tutors* I suggest we need professional development in discourse analysis. Candia Morgan (Morgan, 1998) advocates the introduction of a wide range of the analytical tools of functional grammar (Halliday, 1985) and critical language awareness (Fairclough, 1992a). This seems to me unrealistic in the AE/FE context: for me, a working tutor but with time and support for research, such detailed work has seemed neither necessary nor practicable. However, dominant discourses of adult mathematics education still revolve around ill-defined notions of empowerment, and discourse analysis, albeit at a less detailed level, offers a means to unpick classroom practices.

4.3.2 Discourse analysis and students

This research has shown enormous pedagogical potential in the development of *two discourses with students*: discourse analysis at text level (including speech, writing, gesture and graphical representation) and at the level of student and tutor roles and relationships, with overlaps between the two.

'Discourse analysis with students' has the air of something impossible to achieve in a basic education maths class. I would argue however that there are many examples in this research which show critical identification of discursive features. Examples of students' identification of particular discursive features at text level include discussions of the word problems genre, patterns of questioning in classes, the details of algorithms, differences in diary entries, comparison of maths histories in written prose, in oral discussion and in graph form and comparison of formal algorithms with informal methods. On reading tape transcripts of classes, students commented on how difficult they are to understand when detached from gesture, tone of voice, and written texts. These examples all involve explicit noting of practices, discussion of whether, how and when those practices are 'rule bound', how flexible they may be in different discourses (so, for example, particular qualifications require students to have skills in solving word problems) and consideration of alternatives.

Students' analysis of tutor and student roles overlaps with the textual issues above. Observation of speaking and questioning led to discussion of 'dominance' in the tutor and gender imbalances in the group; discussion of each others' work on an investigation led to discussion of students' different approaches (as well as findings), and hence of the tutor's role in investigative work; tape transcripts expose the 'air time' taken by the tutor; two students' tape about their class and pedagogy was played to the class and led to further class discussion.

These examples arose from particular classroom interests and experience. Many of the articles in *Global Maths* and discussions at the *Meeting for Maths Students for Beginners* show students widening the discussions to include other classrooms.

Such discussions open up spaces for talking about individuals' experiences, preferences and aims in the context of a more explicit view of the dominant discourses of maths in adult education (both curriculum and pedagogy). Students may (probably often do) have an existing perception of maths classes as dominated by particular discourses, whether that be overtly social *(men talk more in classes)* or apparently built into the maths (as Violet put it, *You have to use the right word for maths*). But open discussion of those discourses renders them open to challenge and unsettling: unpacking classroom practices (from subtraction algorithms to tutor's questions) makes them strange, and awareness of patterns of interaction changes those patterns. I have argued throughout that for students' voices to be more powerful, we need to unsettle classroom discourses. I next address directly the two key themes of the thesis, voice and empowerment.

5 Voice and empowerment

The themes of voice and empowerment relate to my first two questions:

> *What does 'radical' mean in adult numeracy work, for me, in Britain, now?*
> *Does the research fit a Gramscian or Freirean model, and if so, how?*

Strengthening the voices of ABE maths students, and empowerment for students through education, are the key themes of this thesis. I argue that while the research has found ways in which students' voices can be heard, 'empowerment' has been within the classroom. I then reconsider the research in the light of Freirean and Gramscian perspectives, and turn to a metaphor of students as researchers. This section is in four parts: voice, empowerment, Freire and Gramsci, and students as researchers.

5.1 Voice

'Voice' has been used as a hold-all for power, so that 'strengthening students' voice' is a metaphor for 'empowering students'. The two ideas are indeed difficult to disentangle and their meanings overlap (Griffiths, 1998), but in what follows I shall aim to use 'voice' as close to literally as possible, so that it refers to students' use of words, whether oral or written, and opportunities to be heard. A second meaning of voice is akin to influence (as in 'strengthening the voice of pensioners'), and suggests that students' voice is having an effect in terms of making changes. I am treating this second meaning as 'empowerment'.

5.1.1 Quietening the tutor

One of the difficulties for me in this research has been the exposure of the strength of my own voice, both literally in terms of volume and the number of times I speak (as Lorraine put it, *tutors are very sort of loudly spoken*) and in my 'dominance' of groups. The first can be tackled directly. Students invoke the notion of voice when they ask that tutors should 'listen' and 'hear', and in planning the *Meeting for Maths Students for Beginners* and the magazine, for example, I struggled to keep my opinions to myself, and that resulted, I have argued, in much more productive meetings.

5.1.2 Questioning the tutor's dominance

In terms of classroom dominance, I argue that making it 'strange' and open to challenge, though joint consideration of discursive patterns, helps us understand when the dominance is a legitimate (not disempowering) rather than oppressive position. Further, the dominant voice of the tutor can be used to promote joint work on understanding classroom discourse and thereby unsettling it.

5.1.3 Using students' texts

My own roots as a literacy tutor, along with the experience of many of the students in literacy groups, led to a continuation of the tradition of using 'students' own words'. Although, as I outlined in Chapter 2, this is nothing like clear cut and is open to much tutor- or scribe-led intervention, it means that many of the written texts shared by students have features which identify written texts as (probably) originating in speech and sometimes also act as pointers to the background of the writer. This remains an important way in which some sense of the individuality of students can be supported, and it values difference in ways of talking and writing.

5.1.4 Student-only discourse

It is essential that some sort of student-only discussion be made available.

> *The notion of democracy is inimical to isolation and individualism ... Justice and rights are social terms, they do not concern hermits! (Woodrow, 1997: 13)*

Student comments resulting from closed meetings (at and around the *Meeting for Maths Students for Beginners*, for example) have been among the most 'new' to me. This is a simple way of limiting the strength of the tutor's voice (though of course it depends on the tutor actively listening to whatever is later shared by the students).

5.1.5 'The same but different': students' voices

Diana Coben comments that

> *The voice that is most rarely heard in debates about the politics and purposes of the education of adults is precisely that of the adult student. (Coben, 1998c: 7)*

I discussed in Chapter 3 issues around how students' narratives can be maintained within this thesis, my own narrative. For me this revolves around a demand for honesty: that I should use students' words fairly, so that when students read, or I explain, what I have written, they do not feel their ideas have been stolen from them and repackaged for some other purpose. I have supported this endeavour where possible by including a lot of material directly from students, from tape transcripts and written work. I hope therefore that this thesis can contribute to letting us hear 'the voice of the adult student'.

However, we need to take into account Mimi Orner's critique of student voice as an oppressive construct claimed in the name of liberation (Orner, 1992: 75):

> *Educators stand above their students, and guide them in their struggle for "personal empowerment" and "voice". The only call for change is on the part of the students. The only people who get "worked over" are the students. (op.cit.: 87)*

Accepting Orner's point, I argue that the present research is defensible, in two ways. Firstly, the tutor's role (it sometimes felt like the tutor personally) did 'get worked over'. Secondly, a central finding has been that we should *avoid* generalising about 'students' at large - that is, students' voices have been heard rejecting the 'binarism and unified subjectivity' critiqued by Orner (op. cit.: 87). If there is one dominant theme to be heard among the students, it is that tutors should listen to, and act on, students' views more carefully, precisely because tutors tend to generalise inappropriately and assume we know what is best.

5.2 Empowerment

We need to be clear that few if any basic education students arrive at a course saying their aim is to be empowered. More typical are requests for qualifications, fractions and decimals, metric measurement, a class with a crèche ... These are absorbed into discourses of empowerment by those who have authority in AE discourses, including tutors.

There are two likely sources of radical and liberal ABE workers' demands for students' empowerment: our own political commitments, and/or an interpretation of students' expressions of wanting more confidence (in maths, as I have argued above) as meaning they need or seek empowerment.

Using an adult education group to further the political aims of its tutor does not, to me, seem an ethical use of the considerable power the tutor has by dint of her/his position. If in fact the political aims of the students and tutor coincide (unlikely), then fine - but I have argued that *finding out* what students' aims may be is complicated and demands changes in classroom discourse which are never complete, never finalised.

Educators may argue that students do not understand their own best interests, a position consistent with Freirean perspectives (e.g. Allman & Wallis, 1995; Lather, 1986). This is as limiting as the domesticating and vocational curricula on offer in official discourses of ABE; students have to go along with the tutor's perception of students' 'needs', with an assumption that maths learning can be incorporated into tutor-set contexts.

The interpretation of students' 'lack of confidence' as a need for empowerment dangerously ignores the tutor's own role. I have argued above that 'confidence' is a function of the discourses and contexts in which we operate - in this case, the ABE classroom. We should be looking, therefore, to 'empowerment' within our own classrooms: it is exactly the political position of the tutor, rather than the student, that should be challenged.

5.3 Freire and Gramsci

I next reconsider from the perspective of this research the key ideas of Gramsci and Freire which have run through my own development as a tutor and my history of conversations with AE friends, both students and tutors. I must be clear that those 'key ideas' are of the sort identified by Coben as 'emblematic' (Coben, 1998c): not based in thorough reading of both authors, but in the pick-and-mix readings of a tutor seeking political grounding for her work. One reason for the 'emblematic' status of Freire and Gramsci in the discourse of radical adult educators may be that they both identify tutors' role as central to political change. It's good to feel important and empowered ourselves; we'd like to feel central to a revolution; it's easier to handle personally than the 'working over' (Orner, above) we have when our own classroom practices are critiqued.

5.3.1 Freire

Freire's identification of a 'culture of silence' fits, oddly enough, with the early (1970s) 'victim' view of people with literacy difficulties, and meshes with a romantic view of 'giving a voice' to students. Freire's process of conscientization involves stages, of which the first is 'semi-intransitive consciousness' (Freire, 1972a; Freire, 1976); it is at this stage that they have a 'culture of silence'. As students work through the conscientization processes, they reach the third stage, 'critically transitive consciousness'. This stage is characterised by

> *depth in the interpretation of problems; by the substitution of causal principles for magical explanations; by the testing of one's 'findings' and by openness to revision;... by refusing to transfer responsibility; by rejecting passive positions; by soundness of argumentation; by the practice of dialogue rather than polemics; ... by accepting what is valid in both old and new. (Freire, 1976:18)*

The work of students in this project, both class members not quoted in the research and the active organisers, fits this third stage, and indeed they had achieved these heights before their courses, and this research, started. Freire's generalising of the position of people who lack formal education is revealed as patronising when we hold it up against real people. Diana Coben argues that Freire constructs the learners as

> *passive, silent, ignorant, unaware, inexperienced, possibly fearful but acquiescent. (Coben, 1998c: 113)*

I have argued that dominant ABE discourses construct students in a similar mould (and we are encouraged to do so in the draft Adult Basic Skills curriculum). The argument from this research is that students can only present their 'critically transitive consciousness' if the discourse of the classroom allows it, and that the tutor's leadership role lies in initiating such shifts in classroom discourse.

5.3.2 Gramsci

Gramsci argued that

> *All men are intellectuals, .. but not all men have in society the social function of intellectuals. (Gramsci, 1971: 9)*

He divided people who had the social function of intellectual into two groups, organic and traditional; the former work on behalf of their class, in educational and organisational functions (Chapter 2).

I argue that if we reduce, drastically, the scale of Gramsci's vision then the work of the students within this project has fitted Gramsci's terms. Coben suggests that PAR fits more comfortably with Gramscian than Freirean perspectives (Coben, 1998c: 166-7). The students have been organic intellectuals working on behalf of their class, if we redirect the meaning of 'class' to mean 'classroom' or, more widely, 'ABE students'. They have, too, been organisers (Coben (1998c:19-20) points up the link between 'organic' and 'organising'), articulating proposals for change and new understandings of ABE to wider groups. This view of students as intellectuals is consistent with Gramsci's proposals for educational processes

> *in which everybody participates, to which everybody contributes, in which everybody is both master and disciple. (Gramsci, 1985*: 25, *quoted in Coben, 1998c: 34)*

This formulation allows tutors both to teach and to 'learn from the students', another of the mottoes from adult literacy education.

Gramsci wrote,

> *We are all conformists of some conformism or another .. The starting point of critical elaboration is the consciousness of what one really is ... 'knowing thyself' as a product of the historical process to date which has deposited in you an infinity of traces, without leaving an inventory. (Gramsci, 1971: 324)*

Though Freire described, in order to oppose, a 'banking' system of education in which students are seen as empty vessels to be filled by the teacher, he oddly seems himself to see students as empty (or in Coben's terms, ignorant and inexperienced). It's clear that for Gramsci no-one is ignorant (and Coben discusses the potential for using the Gramscian terms 'good sense' and 'common sense' in discussion of maths knowledge: Coben, 1998a). 'Knowing thyself' in a maths class might include comparing the different mathematical strategies students have learned, comparing school and AE experiences, unpacking classroom discourse, and so on - all undertaken by students in this project.

So does this research fit a Gramscian model? It's tempting to claim so, since I want to be 'a radical'. But that 'drastic' reduction to the scale of Gramsci's vision is a very serious problem. Gramsci was a leader of a political party seeking revolution, not a part-time tutor trying to work out what to do with the Wednesday 7-9 pm class. I next consider a metaphor of students as researchers as a way of reconceptualising adult basic education, and after that return to Gramsci and consciousness raising.

5.4 A metaphor of transformation: student researchers

> *Those [metaphors] which grip our imagination, and for a time, govern our thinking about scenarios and possibilities of cultural transformation, give way to new metaphors, which make us think about these difficult questions in new terms ... Metaphors of transformation ... allow us to imagine what it would be like when prevailing cultural values are challenged and transformed ... They must [also] provide ways of thinking about the relation between the social and symbolic domains in this process of transformation'. (Hall, 1993, quoted in Owusu, 1999: 6)*

The 'metaphor of transformation' for this research has been to see 'basic level students' as researchers. Our (tutors', policy makers') imaginations have been governed by metaphors of students as silenced, ignorant, unconfident, exploited, unable to run their own (and families') lives efficiently, and politically ineffectual; these metaphors have suited us well, positioning us, in contrast, as articulate (on behalf of others, therefore generous), knowledgeable, confident, politically effectual, agents in our own and others' lives. Positioning students as researchers challenges these prevailing values. 'Researchers' are experienced in their own field yet want to know more; they build on their expertise to formulate new questions; they share their findings with others; they make proposals for change. Above all, they are intellectuals.

This is not to say that students have knowledge of *everything* in a maths classroom; if they were experts in maths, by their own standards, they would not be in the class (though they may of course have expertise in particular uses of maths, or particular strategies, which do not usually 'count' as maths). Regarding students and tutor all as researchers is in contradiction to Freire's 'class suicide' proposal for educators (Freire, 1978). Tutors too are knowledgeable and inquiring; but rather than somehow donating that knowledge, whether of maths or of political structures, to students, we can look on the project of developing democratic practices as a shared endeavour with no preset template. This goes beyond Freire's rejection of a banking model. Freire's 'investigators' established the themes for group study, based, it was claimed, on analysis of local conditions and discussion with local people: but we can be sure that the assumption was that this process, in the end, was determined - that local students *would* come to the 'right' analysis (that is, agree with the investigators).

Stuart Hall writes that identities

> *arise from the narrativization of the self, but the necessarily fictional nature of this process in no way undermines its discursive, material or political effectivity. (Hall, 1996: 4)*

Student researchers have here achieved discursive and political changes in their classrooms.

Consciousness raising

I have identified some links and parallels between the consciousness-raising groups of the women's liberation movement (1970s - '80s) and adult literacy groups (Chapter 2). A reminder about women's CR groups: we were *developing theory out of our own experience and practice*, albeit informed by reading others' theory, and that I argue is what students in this project have engaged in.

The process however has not centred on students' identities as women or men, workers, black or white, economically exploited, and so on, but on their identities as students and on power relations within classrooms (and in my case, identity as a tutor and my uses of authority). Introducing space for such discussion and analysis is a legitimate use of tutors' power; rather than imposing an agenda from outside, it focuses on the conditions necessary for productive teaching and learning of maths, the shared aim. This does not preclude a focus on, say, racism or economic exploitation if that is sought by the group; and since identities are not boxed off from each other any of the categories used for exploitation and exclusion of certain people may be at issue (so for example we have seen (Chapter 5) gender relations disputed as part of the process of analysing group discourse). What it does mean is that a white, middle class tutor (in my case) does not allocate herself a lead role in bringing students to understand what it means to be, for example, black or working class (if I want to do that, I can join a political party, or teach sociology or politics rather than maths).

6 Conclusion

In Chapter 2, I discussed the dearth of written research into the discourse and practices of ABE maths classrooms, and contrasted that with the vigour of what I called an oral research tradition. One of the questions raised in this thesis has been 'What counts as research?' The stories told in this thesis offer unique insights into classrooms and into students' analyses of their own experiences there. I hope the thesis goes some way to link and compare the meanings taken from shared experiences by the tutor-researcher and student-researchers.

I have argued that meaning in maths learning is discursively constructed. This is so from the detail of algorithms to exploring mathematical structures like the 100 grid or the comparatively standardised genre of word problems. I have therefore suggested that we need to ensure that the widest possible range of communicative practices be available. Writing and reading are not separate from talking and listening; students use a range of individual and standard methods; they may choose to work, at different times, alone, with or without a tutor, with or without classroom texts and other students, or drawing on people, texts and problems from altogether outside the educational institution.

But wider meanings are also important. It is not just that students may have different approaches to specific problems or different takes on the classroom. Ideas of what maths itself means, and aims in studying maths, are also discursively constructed - and that process starts long before students meet an ABE tutor. The distinction between 'everyday' maths and academic maths does not capture the complexity I have found and is not a sound base for building pedagogy and curriculum. The implication of the stories collected here is that we should reject universalising discourses, including that of 'empowerment', which can disguise top-down views of what a student 'should' learn rather than facilitating students' own agendas. Such distorted conceptions of 'empowerment' may be found in both government-led and critical perspectives, which propose a single curriculum that is 'appropriate' for all ABE students, and which defines what is 'real' for them, or how 'they' best learn.

We have seen that students measure their progress in maths in terms of confidence. To strengthen students' voices we need to unsettle traditional classroom discourses which position students as lacking confidence and which offer only limited curricula deemed suitable for them. That unsettling has come through positioning students as investigators and researchers, into maths and into their own classrooms. I argue that the role of the radical tutor includes de-centring her- or himself: quietening our own dominant voices, supporting student-student interaction and re-centring students' own narratives, in contexts in which they become the ground material for students to share their work and build solidarity in the classroom.

I and the students with whom I worked have found some generative ways of unsettling our own classroom discourses and sharing some of our shifts with others. I can claim useful things to say about maths classrooms, but on the road I have rejected grand political claims for ABE tutors' work.

The conclusion this research has led me to could be taken as offering pointers for a better ethical base for ABE work, but not a more radical political base. I would disagree with this reading and argue, instead, that for me, the two go together. This conclusion is supported by the research itself. What it tells us is that radical tutors – 'those who aspire to a progressive social and political purpose in their work, who want change in the original meaning of "radical", "from the root"' (Coben, 1998c: 3), in the 'democratic' sense I present above (see analysis of question 1 in Chapter 1) – need to focus our attention more closely on the sites in which we have most authority: our own classrooms.

We have to start from the skills we have and our present understandings of the world; we have to do what we can, without pretending it is more; but we also have to be optimistic. A more democratic classroom though small scale is not trivial. Classrooms are not in some way 'unreal' by comparison with a 'real world' of 'real politics'; and ABE students working as intellectual researchers have both illuminated and changed that real world.

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Appendix 1: Some difficulties in claims made for writing in mathematics education

> *Mathematics sense-making [in the next millennium] will require [children] to read, write, experience, explain, discuss, defend and clarify for themselves and others what are sure to be cognitive dissonances in their realities. The teaching of reading, writing, and arithmetic in this increasingly symbol-laden society will need to be shifted to reading and writing about [original emphasis] mathematics, if true mathematics literacy is to be achieved...*
>
> *Who can best help move a nation and its children to "spreadsheet" thinking and mathematics meaning-making? [We] believe the answer is communities of people (students, teachers, and others) willing to have open, honest, constructive dialogues about mathematics and what it means to be mathematically literate. As children begin to experience the power of their mathematics literacy, they will question an educational system that gives power and privilege to a few while relegating an inordinate number of people to lives of mathematical inarticulateness (Elliott, 1996, p. ix).*

I hope this extract from the National Council of Teachers of Mathematics 1996 Yearbook *Communication in Mathematics*, a collection of papers which amounts to a mission statement, will serve to point to some of the questions I want to raise here.[1]

What does *'literacy'* mean in the context of mathematics education? The authors imply the meaning of 'mathematically literate' awaits definition, but it seems that mathematics literacy is something that gives power to children to *question the educational system*. Is literacy so powerful? And are all mathematically literate people on the same side of the fence?

Mathematical literacy here is probably being used to mean something like sufficient confidence in mathematics to enable the possessor to be critical and free thinking.

I want to consider some of the claims in recent literature made for writing in mathematics education - one common sense view of what the development of mathematics literacy might involve. Writing within mathematics seems now, at least for the influential NCTM, to have achieved the status of a pedagogically given good - a kind of benign hegemony of writing. Thus Huinker & Laughlin (1996) seem to write from a pedagogical context in which *writing* has become more accepted than *talking*, and Greenes & Schulman (1996) write of using mathematics as a vehicle for communications skills, implying that the communication skills are central and the mathematics is peripheral.

Marwine summarises her/his reading of the literature about writing within mathematics:

> *Reading what students write permits insights into their own views on the material ... we actually get to hear* what *they are thinking and* how *they are thinking it (Marwine, 1989): 59).*

These are grand claims for writing within mathematics. I want to look in more detail at some of the assumptions and contradictions in these debates, and hold up some of the claims for writing against my experience and the experience of students I am working with. I will consider the following questions:

1. Does writing entail critical reflection, and does that lead to enhanced learning? Some of the claims made are:

    1. writing enables learners to come to personal understandings of mathematics topics
    2. writing facilitates dialogue
    3. writing is a means to keep students actively engaged in mathematical study
    4. writing is more precise than speech; the effort to be more precise aids students' acquisition of mathematical concepts

2. Who is the audience or readership?

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[1] This paper was written at an early stage in the research, and there are some overlaps with discussions in the body of the thesis: these are indicated in footnotes.

3. What *is* the 'writing'? This involves questions of genre and of distinguishing writing from talking.

1 Critical reflection enhances learning

A strong theme in the literature is that critical reflection enhances learning, and that writing within mathematics enhances critical reflection. The broad arguments are that writing is personal, demands precision and is a communicative endeavour; furthermore, the act of writing externalises the ideas so they can be revisited and developed. Versions of these arguments are put by many writers, including Borasi & Rose (1989), Connolly & Vilardi (1989), Countryman (1992), Powell & Ramnauth (1992) and contributors to the NCTM *Yearbook* already quoted.

1.1 Writing in mathematics is held to offer the opportunity for 'personal making of meaning'

> *[Writing] can prompt students to reflect critically on their mathematical experiences and respond to mathematical situations and questions that are personal and of their own choosing. (Powell and Ramnauth, 1992: 17)*
>
> *'Through the process of their journal writing students increasingly interpret mathematics in personal terms: constructing meanings and connections'(Clarke, Waywood, & Stephens, 1993): 243).*
>
> *[*Writing to learn *can provide a means to facilitate] "a personalized and making-of-meaning approach to learning mathematics" (Borasi & Rose, 1989): 347).*

I would argue that this comes close to investing 'writing' with magical powers. The caution in the 'can' of the first and last quotations begs key questions: can *in what context*, can *in what discursive setting*?

The three quotations above all come from articles specifically addressing students' writing in mathematics diaries or journals. I will illustrate the points I want to make by looking at some diary writing by Jim, Paulette and Cindy. All three attended a two hours weekly, year long 'Basic Mathematics' course run by the local education authority, that is, the entry level course. It has between five and nine students usually attending in any one week, and these three students were all regular in their attendance. I was the teacher. We usually stopped about ten minutes before the end of the class, and the students wrote their diary for the week. Those who had difficulties with reading and/or spelling dictated their diary to me or got help from other students.

Jim is a Guyanese man probably in his 40s; he identifies as an English speaker only, though he also speaks Hindi, his mother tongue. He has very poor eyesight and uses a thick pen and blown up worksheets. He is schizophrenic; he has a different take on the class from anyone else there, often seeming to plunge into the middle of a new topic with little warning. He doesn't talk to me or the other students about his past or his prior education, so I know nothing of his schooling. His mathematics is 'better' than most of the students'; for example, he is entirely confident with place value and decimal numbers, converting currency and calculating percentages. I am not clear why he comes to the course, since I think the 'straight' mathematics is usually too easy for him.

During this class, Jim worked on fractions, and had problems *seeing* (I think both literally and metaphorically) whether he had succeeded in dividing a circle into 5. He had divided a circle into 8 (varying in size) pieces, but counted them as 5. When it came to writing the diary, I held the pen to take dictation, and we had this exchange:

Alison: *What* did you do?
Jim: *I did a circle.*
Alison: (writing and reading aloud so Jim could know what I was writing)
'I did a circle.'
How do you feel about it?
Jim (pause): *I feel ok.*
Alison: (writing) *'I feel ok'.*
Did you find it difficult?
Jim (pause): *It was* (pause, small chuckle in voice) *slightly difficult.*
Alison: *'It was slightly difficult.'*
What was difficult?

Jim:	*Drawing the lines.*
Alison:	*To get the number of pieces right?*
Jim:	Yes.
Alison:	*'Drawing the lines was difficult to get it into the right number of pieces'.*

This is the finished diary entry, in my handwriting:

> *I did a circle. I feel ok. It was slightly difficult. Drawing the lines was difficult to get it into the right number of pieces.*

In terms of finding out how Jim 'feels' about his work, or what his particular difficulties were, this is useless, and I knew so at the time. I persisted because I think it's possible more experience of diary writing may help Jim get an idea of what is possible (it is likely that people need to *learn* to write mathematical diaries); because I want to keep him integrated so far as possible with the work of the rest of the group; and because in general I want to keep routes open.

'Circle', 'ok', 'slightly' and 'drawing the lines' are the only new ideas spoken by Jim before me; that is, almost all of this was not only scribed, but authored, by me. The overall structure - the questions Jim answers - came entirely from me. The one thing Jim introduced entirely himself, the chuckle about defining the level of difficulty, is omitted from the final text. So it's not clear that I managed to 'keep the routes open'; I may simply have narrowed Jim's options into the particular words I thought would 'answer'.

Jim is 'different' from other students in that he is ill, and it may be argued that his diary-writing is therefore irrelevant to anyone else. In fact adult education now includes many people recovering from mental illness. However, my case is that it is difficult to generalise from *anyone's* experience. I would argue that a reading of Cindy's and Paulette's diaries[2] could support the Borasi and Rose (1989) claim, quoted above, that 'writing to learn' can facilitate 'a personalized and making-of-meaning approach to learning mathematics'. These two students' writing and their own comments on it show, however, that this is not a single, homogeneous approach.

There are personal variations in the uses, or absences, of writing. The writing, in these examples diary entries, may relate to personal affective issues; to 'straight' mathematics records; or be composed of answers to a teacher's questions. It may be written from choice, from pressure, or from something close to force (Jim was more or less trapped into answering questions; he could not have left, or refused to answer, without being rude). The difficulty is that teachers may reasonably *read* the diaries as demonstrating 'personalised' and 'making meaning' approaches to mathematics; the text alone cannot tell us the student's relationship to the text.

1.2 Writing facilitates dialogue

A strong claim for writing within mathematics education is that it promotes dialogue.

Powell and Ramnauth (1992) show writing that is much closer to dialogue than most. It is written in turns by the teacher (Powell) and the student (Ramnauth), in a genre they call 'double-entry logs'. Possibly as a result of this close conversation in writing, they keep the focus on mathematical content. It can be read as an extended version of 'marking' Ramnauth's work. They mention, but don't elaborate on, students' reading and commenting on each others' logs:

> *we observe that logs can initiate mathematical dialogue and furnish excuses for sustaining that dialogue (p. 16).*

We should compare this with Jim's diary entry discussed above, where my role in the writing is so dominant as to make the text more mine than his. Marks and Mousley (1990) advocate a process of 'shared construction' of texts. Most of the writers discussed here, however, assume the dialogue is not directly in the process of writing but in the teacher's reading of the student's writing. Clarke, Waywood and Stephens (1993) categorised students' journal entries as Narrative (or Recount), Summary or Dialogue, and found that progress in journal writing meant progression through those three stages:

> *'in the Dialogue mode, students are involved in creating and shaping mathematical knowledge' (p. 248).*

---

[2] Discussed in Chapter 4

Miller (1991) outlines the general case for writing within mathematics education:

> *The construction of knowledge requires active engagement in thought-provoking activities. Because writing leads people to think, improved mastery of mathematics concepts and skills is possible if students are asked to write about their understanding. Because writing in mathematics involves many of the thought processes teachers would like to foster in their students, every mathematics teacher should seriously consider the use of writing as a part of the daily routine of the mathematics class. (p.517)*

Borasi and Rose (1989) cite Vygotsky as the source for a 'dialectical' view of the relationship between language and thought, and it is clear that Vygotsky, or Vygostkyans, have had a strong influence on the NCTM position. However, the evidence of 'dialogue' is thin. I want to compare some of the few teachers' responses - teachers' parts in the 'dialogue' - given in the literature to my own experience.

Clarke, Waywood and Stephens (1993) argue that the teacher attempts to move students towards taking on responsibility for their mathematical thinking:

> *The key [to a shift to the dialogue mode] appears to be to encourage students to question themselves when they do not understand rather than be dependent upon their teacher to tell them whether they understand. This requires an internalization of authority, responsibility, and control. (p.248)*

Yet the only journal comment from a teacher quoted in the article is this:

> *Unless you can explain it to me, you don't really understand. (p. 248)*

Miller (1991) says writing is a way of 'stimulating dialogue between student and teacher' (p. 518) but suggests timing students' writing with a kitchen timer - not a tool normally used to facilitate dialogue. The teacher's response need not take long:

> *A set of twenty-five to thirty pages [each page from a different student] can be read in five to ten minutes. (p. 519)*

Countryman (1992) suggests some possible tutor responses to 'help students make better use of language to explain what they are learning':

> *'Try to fill the page'*
>
> *'Write more than a sentence or two'. (pp. 34-5)*

What we have here is a frighteningly limited view of the teacher's role in the supposed dialogue generated through the medium of writing.

'Dialogue', outside the arena of education, suggests a more or less equal exchange between two people, or groups. Each listens to the other; each puts their own points when they want. Yet in mathematics education we assume the student will write on the topics proposed by the tutor, which may include personal or affective issues as they relate to the study of mathematics; we assume the tutor will comment on the students' writing, but will *not* introduce her/his own personal 'business'. I will start by looking at the ways tutors set topics and organise 'scaffolding' for the writing, and go on to issues of tutors' own emotional reactions.

In my own practice, I have used a 'diary sheet' which asks students to consider these questions:

> *What have you learned? Did you find out anything new?*
>
> *Are you stuck on anything? Do you want to ask anything?*
>
> *Do you want to move to something new?*

As we have already seen, this set of questions elicits a wide range of responses, from boredom to enthusiastic writing on varied topics. The sheet labels the questions 'ideas for writing', suggesting, I hoped, that the questions were not to be seen as limits but starting points. Yet just as important is the space allocated to diary entries: about 6 cm for each class. I had intended this space to indicate that the students (many of whom are not confident in spelling) need not write a great deal; that was the extent of my thinking about it. But Jim sees the space as a challenge - both each week ('no more space today, that's it, stop now') and overall ('nearly filled up the sheet'). Paulette and Cindy, asked 'Is the diary sheet ok?', said this:

Cindy *I suppose she just means is there enough space.*

Paulette *Mm hmm. You can always go down to the next.*

Cindy *Yes exactly, but it's quite nice knowing that you don't have to go any further. I wouldn't like to have to write reams of it, would you?*

Paulette *No, no, I think the diary sheet is fine.*

These are not people who see their diary sheet as an opportunity for a dialogue; Cindy, at least, clearly sees it as an obligation. What I thought was a *friendly* line across the page, giving people the opportunity to *stop* writing when they reach it, becomes here a target that you must reach. Again, I don't want to generalise from this to say that no diary writing can be a dialogue. One student, Alison, used her diary to comment on her feelings on stopping the course. She did not speak to me in person about leaving the course; when I read this, I wrote to her, in something closer to a genuine written dialogue:

> *I need more practise with conversions, however I feel I'm learning now ... I am disappointed that I may not be able to return next term as I have to do training for work. I'm not sure yet about what is happening as I have not heard from my training provider.*
>
> *I do feel that what I have done so far has been of help and I want to carry on practising whatever.*

There are many practical suggestions in mathematics teachers' journals for work to 'support' writing (for example, Shield & Swinson, 1996). Students commented favourably about a framework I offered for some writing on percentages:

> *It helps, it helps better than maybe asking us to write about what we have been taught so far, or our feelings so far from day one up to this point. We may probably won't be able to know. (Violet)*
>
> *Without it I wouldn't know where to start from. (Joyce)*
>
> *It gives you a direction. (Dave)*
>
> *It gives you a bit of ideas so you write what you're supposed to write. (Frank)*

This seems positive, but we should note that Frank is looking to find out what I want him to write, rather than finding an opportunity to 'express himself'. About a different 'starter' sheet, Dave said 'some of the questions are not really worth answering'.

The evidence from students is that the 'scaffolding' we offer may be a support but may also act as a constraint. This point is made by Taylor (1995), writing for literacy tutors:

> *Realising that a student is daunted, teachers often respond by taking away much of the risk and responsibility that made it hard to start. They give students pieces of work which they are 'supposed to write' in a certain way. At one level this involves teachers putting words into students' mouths. At another level it involves 'framing' students' work for them. And at another level still, teachers obliquely tell students what to do, leading to ... students writing what they think the teacher wants. One way or another, this dilutes the students' sense of writing for themselves ... The function of the writing for the student is to satisfy someone else's challenge. They have missed out on both risks and rewards. ...On the page gridded by expectations, any mark is a potential error. On the blank page, any mark is a success. (189-90)*

My argument then is that for some people, at least some of the time, whatever the good intentions of the tutor, the 'dialogue' is not free; it is constrained by topics and structures imposed by the tutor. I like the phrase used by Powell and Ramnauth, quoted above:

> *'logs can initiate mathematical dialogue and furnish excuses for sustaining that dialogue'. (1992; p. 16)*

This at least admits the artificial nature of any effort to establish dialogue between two such unequal parties.

So far in relation to 'dialogue' I have concentrated on the student's part. I want now to look at the tutor's responses. These may be writing-technical ('try to fill the page') or mathematical-technical (as are Powell's responses to Ramnauth). I have found no-one in the mathematics literature tackling the question of how the tutor deals with affective, emotional responses when corresponding with students through their diaries, or orally responding to what they read (there is a discussion of tutor's emotional involvement with students through their diaries in feminist pedagogical theory; see for example bell hooks, 1994) . I will give three examples, one from writing, one from a student-student discussion and one from relationships within groups.

The first comes from Cindy's diary. As I have said she writes about her feelings in relation to mathematics - for example, 'still feeling confident in class', or 'felt rather deflated - either things are too simple or too complex'. One week she wrote,

> *Basically I think my maths is wrong.*

This threw me into a panic. My own diary that week said,

> *What can I say? I don't know what I can put.*

I didn't know what to put because it mattered so much. I hadn't 'known' until that moment that Cindy felt so weak in mathematics (the inverted commas are because part of my argument is that reading someone's writing doesn't necessarily lead you to 'know' them at all); the fact that she did think her mathematics was 'wrong' meant my efforts at 'confidence building' in the classroom had not worked. I tried out different responses which all sounded patronising; they seemed to be variations on a theme of 'Don't worry, it will turn out alright, just trust me'. The fact that regular attendance and hard, committed work at mathematics in my classroom had *not* improved her confidence in mathematics made me feel that any response from me could well be an irrelevance and an intrusion. In what sense were we developing a dialogue? I think Cindy may well have written this to make me pay attention; she had said in the class that her mathematics was poor, and I had (I thought creatively, but perhaps only dismissively) disagreed with her. Her diary entry was challenging because any response which would satisfy me, and represent properly my reactions, would need to address three difficult areas: definitions of mathematics itself and of right/wrong in terms of mathematics; Cindy's purposes for study; and Cindy's earlier mathematical history. It was the teacher here who needed to improve her skills in written dialogue.

When Cindy and Paulette interviewed each other about their diaries they used the one open question ('Any advice for other students or tutors?') as an opportunity to criticise the attendance patterns of some other students (Paulette) and the teaching style of the tutor (Cindy). Their interview tape was made in the kitchen where one of them lived, and I was given the tape. The tape includes cheerful mimicry of me the teacher (in a high, 'teacherly' voice), and a few minutes later a critique of my teaching ('wishy-washy'). As I transcribed the tape I had an awful foreboding of what was to come; I could transcribe only a few minutes at a time; I dreaded continuing in case it got worse. Here we have students seizing an opportunity to make the agenda their own, without interruption by the teacher (what they say is still constrained, of course, by the knowledge that the teacher will be listening to the tape).

My third example comes from two separate groups. In both groups I thought I had the confidence of the students, who wrote diaries every week, relating as they chose to the mathematical content, their own learning, or both; I would have said that both groups were well integrated, worked well together, were supportive, and so on. I had no idea there was any problem internal to the student group. Yet in both groups I was told that some of the women students were being sexually harassed by one of the men. By the time I heard of this, the women had discussed it amongst themselves and decided how to deal with the problem. In some ways this is an uninteresting story; we know that sexual harassment is part of the world we live in, and there is no reason to suppose mathematics classes are a safe haven. The problem then is that *because* the students were invited to discuss the progress of the group and their confidence within it in their diaries, I thought I knew what was going on. I thought the dialogue was real, but it couldn't be. The roles of the people within the group mean that I am separate from the group precisely when issues of power and control are problematic (the women knew I would 'deal with' the problem as soon as I heard of it; they took time to attempt to deal with it themselves before passing the problem upwards for arbitration).

My concern is that it is too easy to see 'dialogue' as a simple good. What passes for dialogue is usually tutor-directed, coming (perhaps necessarily) from a top-down, tutor-led structure. This is so even within classrooms where we are committed to developing open and democratic practices. The hierarchical nature of the enterprise is further evidenced by the prevailing assumption that reading students' journals is easy; any difficulty is assumed to lie with the student (and particularly with the student's ability to express mathematical ideas, not with the student's emotional or social position in the group). This supposes that what is said will not be challenging to the teacher at any level, in the mathematical, pedagogical or emotional spheres. If we don't have to take seriously the tutor's end of the 'dialogue', then it's not a dialogue between equals.

1.3 Writing is a means to keep students actively engaged in mathematical study

One argument put forward for writing in the mathematics classroom is that it keeps students actively engaged in mathematical thinking. This argument is supported by McIntosh (1991) and by Countryman (1992), who says:

> *Writing in the classroom means that everyone is active. With talk, whether it be lecture or discussion, only one person is speaking at a time. The rest of the people in the room may participate by active listening and notetaking, but it is easy for some students to disengage, or let the few who dominate the class do all the work. Writing first and then talking about what was written means that everyone participates and more collaboration among students is possible. At the end of these collaborations students can write descriptions of what has transpired. (p. 90)*

This makes an assumption that students are *able* to write down their mathematical ideas, so it relates closely to the next claim for writing (section 1.4 below),that writing is more precise than speech. It's a curious claim. A common sense view might be that children (these mathematics writers' subjects) are more likely to be 'active' in talking, and that writing is a way to keep everyone *quiet* - physically *inactive*. It provides concrete evidence of whether the writer has done some work, so it's a tool for classroom management. Experience in adult education classes flies in the opposite direction. Most of the time more than one person is speaking (this is very noticeable when transcribing tapes), whether as part of a whole group discussion, or because a number of smaller conversations are taking place. Students very rarely 'disengage', probably because they are in the class of their own volition. These are some comments from students on writing on a set mathematics topic (as opposed to writing mathematical diaries):

> *Some people don't write so much if they might not be able to spell it. (Tanya)*

> *I can't express myself, not on paper. I am hopeless in writing. (Marguerite)*

> *You have to construct it. With speech, you only have to do a few words ahead. (Barry)*

Writing as a class 'starter' activity, as proposed by Countryman and McIntosh, is seen as a lonely, unsupported and risky activity:

> *Writing is more permanent than speech. With speech, your voice has emotional content as well, but not in writing. (Barry)*

> *Speech is more emotionally binding. Writing needs more confidence. (Marguerite)*

We could argue from this that students are genuinely seeking dialogue, and that the most obvious way to get a dialogue is in conversation, not in writing.

One person I have worked with, Frank, reports that he would rather work through the medium of writing, precisely because it offers silence:

> *I do think writing really helps you to concentrate, with the rest of the students not saying nothing. It would be very hard if people are talking at the same time for the teacher to understand what the student in the classroom is saying.*

We should notice here that Frank asserts the value of a quiet class for the teacher as much as for the student.

Again, then, it is unreasonable to suppose that one approach works for all students.

1.4 Writing is more precise than speech; the effort to be more precise aids students' acquisition of mathematical concepts

I have already quoted the argument from Miller (1991) that writing leads people to *think* and therefore supports improvement in their mathematics. Countryman (1992) argues that the composition of writing and problem solving using mathematical tools are similar processes;

Kenyon (1989) argues that 'writing *is* problem solving'. McIntosh (1991) more specifically says that writing requires more precision that talking. A similar case is argued by Masingila & Prus-Wisniowska (1996):

> *Writing can help students make their tacit knowledge and thoughts more explicit so that they can look at, and reflect on, their knowledge and thoughts. (p. 95)*

This can only be the case, surely, if the students' writing is well enough developed to enable them to express 'their knowledge and thoughts'. One group of eight adult students worked with me on finding patterns and structures in a grid of the counting numbers up to 100[3]. They wrote, or tried to write, their findings, then shared their work together and discussed it. This is a small sample of their comments during the reading-out and discussion:

> *I've lost myself a little bit, because I didn't write it down properly. (Dave)*
>
> *Maybe at the time he was doing it [writing], he was sure what he was doing, and now that he is going over it ... (Violet, talking about Dave)*
>
> *I don't know how I did it. (Dave)*
>
> *Is that what we meant? (tutor to co-writer student)*
>
> *My last sentence didn't make sense. (tutor)*
>
> *I got totally confused. (Yvonne)*
>
> *I don't know what I mean... (Violet)*

One area of difficulty is the use and meaning of prepositions: 'the numbers jump up as they go down', for example. Interestingly E.W. Orr (1987) claims that non-standard usage of prepositions is a major cause of difficulty for black US students; in this discussion the tutor (speaking something close to standard English) had as much difficulty as anyone else. We could say this is evidence that analysis of their own writing led students to *want* more precision. The writing did not in fact make their thoughts explicit; it failed to do so to such an extent that students and tutor were unable to reconstruct some of their ideas from their writing. It seemed to me that some of what the students were attempting to explain in their writing cried out to be written in mathematical notation; that mathematical notation has been developed, surely, in response, over the centuries, to the difficulties of expressing some mathematical ideas in natural language. During the discussion students repeatedly referred to their diagrams (often colour coded) to clarify their arguments; diagrams are a part of 'standard' mathematics notation. It is not clear then that 'writing' (by implication in a specialised version of natural English, rather than in 'mathematics') helps students clarify or express their mathematical thinking. (Again, I cannot claim from this evidence that no students will develop greater precision in their mathematical thinking through writing; I am seeking only to challenge blanket prescriptions.)

2 Who is the audience?

Most advocates of writing within mathematics see it primarily as a means to improve teacher assessment of the student's mathematics. Clarke, Waywood and Stephens ((1993) report students' journals as a means of formal, graded assessment; others, including Borasi and Rose (1989), Countryman (1992) and Masingila and Prus-Wisniowska (1996) also focus on students' writing as a means to greater teacher understanding of the student's mathematics, whether or not that implies formal assessment. A few writers specifically suggest other students (peers) as the audience (for example, Siegel and Borasi, 1996). Phillips and Crespo (1996) report creative correspondence between trainee teachers and school students.

The examples already given will serve to illustrate the difficulties of using students' writing as a means for a teacher to understand a student's mathematics. Journal entries may misrepresent students' thinking; they are often shaped by a tutor's thinking, not the student's; they may simply ignore the main issues. Indeed it is likely that the more formal the assessment system, the less honestly a sensible student will complete a journal entry. More directly 'mathematical' writing may fail to represent a student's thinking, because the thinking is too complex.

---

[3] Discussed in Chapter 6

Marilyn Frankenstein (1989) writes for a solitary independent reader, not a class student, and both quotes students' writing on mathematics and on their mathematical history, and invites the reader to write. There is no teacher to read the student's writing and the writing has an entirely reflexive purpose. Yet we should consider the extracts from students' writing included in Frankenstein's text. She is giving those writers an audience; she is proposing to her readers that they can learn from other students' experience, expressed in their writing. Perhaps Cindy ("To be honest, I probably wouldn't have read my diary') would have found her diary more useful had she been working alone, with no other person with whom to share insights. Paulette, meanwhile, uses her diary as a kind of dialogue with herself: 'you can reflect back on what you're doing right or wrong. It's something you can refer back to later on'. She is her own audience. Frankenstein's work may resonate more usefully with my view of students' experience simply because she is writing for an adult and possibly failed (in maths) audience.

Curiously, most of the writers advocating writing within mathematics education assume it gives the *writer* time to reflect on the writing. This surely depends on the scale of 'time'. Writing is slower than speech; I can say 'I found that difficult' more quickly than I can write it. Perhaps the slowness is assumed to make reflection automatic. On the other hand, one student pointed out to me that speech allows more reflection because you can watch/listen to your hearer's reaction, and alter what you said (this comment led to Marguerite's response quoted above, "Speech is more emotionally binding'). Part of the reason for the flexibility of speech is that it is fast so you have time to adapt and develop it; it is composed on the hoof in relationship with the hearer. The comparatively permanent record of writing means it is available for later redrafting, but few of the students I have seen working on writing engage in redrafting after its initial reading, unless it is intended for publication in some form.

I suspect a reason for students' writing being seen as a tool for assessment is that it allows the *reader* time to reflect on the writing. I quoted above from a group reading out their own writing and having difficulty understanding it. The whole group engaged in trying to understand the writers' ideas. While group discussion continued, individuals went back to a sentence of writing to try to unravel its meaning, and brought the new interpretation back to the group. The speed of speech may mean a listener can get lost; with a written text a reader can go at her/his pace.

Some of the students I work with have had appalling earlier mathematics histories and some therefore seek to avoid disagreement with a teacher. If I question what they say, often only because I don't understand it, they will change their statement in the hope of achieving the 'right' answer. A written text is more open to examination. (That doesn't make it more *true*, of course.) The text then becomes a vehicle for talk: as Powell and Ramnauth say, the text can 'furnish excuses for sustaining [a] dialogue'. I will give examples from Frank and from a group discussion.

Frank worked at home on a problem to do with area and perimeter. These are some of his sentences:

> *The rectangle is not the same shape outside and inside.*
>
> *The rectangle shape would have the same shape inside and outside.*
>
> *The shape will be longer with the same perimeter outside and inside.*

These are taken out of context, but the difficulty is that the context did not help me make sense of Frank's writing. However, Frank and I spent 45 minutes discussing this writing and explaining our ideas. The physical paper provided a focus for a discussion, and a record of some changes in vocabulary which made Frank's meaning clearer. The fact that the discussion was able to start from Frank's terms helped him, I think, sustain the debate.

I quoted above from a discussion in which students read out their own writing for others to debate. Yvonne said, on reading her own writing, 'I got totally confused.' Rather than ignoring her errors the group embarked on sorting them out for her. One of her written statements was 'each across jumps up by 90'; beside this Yvonne had written 'Wrong'. The discussion went on for about five minutes as students debated whether she was right.[4]

[4] Chapter 6

3 What's 'writing'?

Much of the .literature on writing and/or communication in mathematics classrooms takes 'writing' as a given. It is not defined or challenged. There is some discussion of genre within mathematics writing (for example, Marks and Mousley, 1990), but most writers leap to proposals for specific teaching strategies to develop writing.

I have already raised issues around authorship of the writing, through the discussion of Jim's, Cindy's and Paulette's diaries. The 'support' offered means that in effect the tutor has defined (at least some of) the shape and content of their 'personal' writing. I want now briefly to consider the borderlines between speech and writing, using examples from a taped student conversation and a group discussion of written work.

When Cindy and Paulette discussed their diaries together, they had a list of questions I had given them. The students' diaries are written; the taped discussion was spoken. But the borders are very fluid. The discussion was framed around written questions, and those questions, reappearing as curiously neat, formal sentences in the oral discussion, define a 'written' feel to it. The discussion is framed like a radio programme and has a scripted feel, even though it comes (I suspect) from playing with a Jamaican tradition of formal public (oral) speechifying:

> *So, that's all I have to say. So I just wish everybody health and strength and happiness...This is Miss Paulette and Miss Cindy doing the recording, on writing diaries. Ok thank you bye bye.*

The students' editing of the discussion, by turning off the tape, gives their discussion an element of planning and control over timing and content that are usually not available to interview subjects. Paulette played part of the tape to their group. The tape was intended for transcription, and the complete transcript and three edited sheets (writing diaries; advice for students; advice for tutors) will be available at a student meeting as a basis for discussion of maths classes and student-tutor relationships.[5] Paulette will probably go to the meeting and may further amend the text through discussion of it. It doesn't seem helpful to define this text as *writing* or *talking*, or the audience as *reading* or *listening*.

By contrast, the writing on the 100 counting numbers grid was not initially intended for publication; I suppose the students thought I would be the reader. However, the work was done in a cramped room in which every word spoken is available to everyone there. The arithmetical work - adding, subtracting and so on - was not separate from the 'writing' and the sums are included on the same sheets as the words. Some of the students' written work had identical calculations and reflected their joint endeavours. When these texts were read aloud to the group, the author/reader transformed them. Sums were read aloud and explained: a calculation on the page written as

$$1 \times 2 = 2$$

$$11 \times 2 = 22$$

becomes 'So if you times it. So, the first one I got 2, the second one is 22. So I have got 20 more' (Violet).

Similarly Yvonne's written text was entirely impersonal; the only pronoun is the indefinite 'you', and the agents of the action are rows, columns and numbers. When Yvonne 'read' her text, she made it into a personal narrative with these insertions:

> *I do think that works out wrong....*
>
> *I've said it goes ...*
>
> *And then, I looked at (.) how the grid would change if you didn't have a 10 grid, you had a (.) like a 5 grid or a (.) 3 across.*
>
> *I've written ...*
>
> *See (.) if you look at the 3 grid ..*

---

[5] The *Meeting for Maths Students for Beginners*, discussed in Chapter 9.

These in-the-reading additions have the effect of turning the text into a personal narrative in which Yvonne is the agent and speaks directly to the reader/hearer.

Again, the borders between talking and writing, reading and creating are not defined.

4 Summary

A theme running through the contradictions outlined here is the side-lining of real relations of power in the mathematics classroom. The 'NCTM line' seeks to promote dialogue between students and their teachers, but ignores both the power of standard mathematics itself (as a gatekeeper to jobs; as a stamp of intelligence) and the authority of a teacher's role in relation to general course management and the specifics of a worksheet or 'writing frame'.

'Dialogue' is not commonly available, I would argue, between mathematics students and their tutors. It is folly to suppose students will see *assessed* work as part of an equal exchange, and even unassessed work is subject to the 'scaffolding', 'frames' or 'support' of wording, space, framing and so on provided by the tutor. The topic, the range of opinion available, the length, sometimes the vocabulary are largely controlled by the tutor. The mathematical writing most commonly produced by tutors, I suspect, is the questions which form the basis of classroom work, and the planning of lessons, but these are not areas in which students are usually invited to write[6]. In some cases writing has provided a wonderful *vehicle* for dialogue between students - a hook onto which to hang further exchanges. We could interpret that, though, just as evidence that when they are allowed students seek dialogue through *talking.*

The complex history of a piece of writing means we need to consider questions of authorship. Students are writing within particular genres (though they may be creating their own, as we saw with Paulette and Cindy's tape), influenced by their reading, their tutor and their colleague students. We cannot expect students to have a grip on these genres if they do not *read*, yet the texts written by students are usually read by teachers, not their peers.

I want to raise two more basic problems. Firstly, there is a general view that writing is 'good for students'. It is variously claimed to help them express ideas more clearly; think better; confront and deal with affective issues; develop a critical attitude to mathematics; develop a critical attitude to the 'educational system'. The more closely we examine these arguments, the more patronising they seem. They all start from a deficit view in which students are unconfident, inarticulate and uncritical of authority. For this discussion to have anything to do with critical education or dialogue we need to consider teachers as well as students. There is negligible recognition in the NCTM literature of the difficulties teachers may have in dealing with their own reactions and crises: the possibility that students *are* articulately critical of their mathematics education and can *choose* when and how to express that (like Paulette and Cindy) seems not to exist in the small world in which students 'need helping'. Students' histories may be more difficult than we can cope with: Dave refused to write his mathematics history because it would be too distressing; Cindy left the course. These possibilities do not appear in the literature; the teachers stand on a mountain gazing tolerantly down on the struggles of their innocent students.

The last problem is the greatest. The whole idea that we can discuss 'writing' seems doubtful in view of the complexities of how marks are put on a page and words are read from them. Authorship is shared; what is read out varies from what was written; numbers and shapes weave in and out of words, and are transformed into words in the reading; readers make their own notes of calculations or shapes in an effort to understand the text. It is not one language mode, clear and distinct from reading, talking or listening.

I make no claim that advocates of 'writing' in mathematics education are wrong. I am arguing only that we need more subtlety in our explorations of how people communicate their mathematics to each other.

Borasl, R., & Rose, B. J. (1989). Journal Writing and Mathematics Instruction. *Educational Studies in Mathematics*(20), 347-365.

Clarke, D. K., Waywood, A., & Stephens, M. (1993). Probing the Structure of Mathematical Writing. *Educational Studies in Mathematics, 25*, 235-250.

[6] Discussed in Chapter 8

Connolly, P., & Vilardi, T. (Eds.). (1989). *Writing to Learn Mathematics and Science*. New York: Teachers College Press.

Countryman, J. (1992). *Writing to Learn Mathematics*. New York: Teachers College Press.

Elliott, P. C. (Ed.). (1996). *Communication in Mathematics, K-12 and Beyond*. Reston, Virginia: National Council of Teachers of Mathematics.

Greenes, C., & Schulman, L. (1996). Communication Processes in Mathematical Explorations and Investigations. In P. C. Elliott (Ed.), *Communication in Mathematics, K-12 and Beyond* (pp. 159-169). Reston, Virginia: National Council of Teachers of Mathematics.

Huinker, D., & Laughlin, C. (1996). Talk Your Way into Writing. In P. C. Elliott (Ed.), *Communication in Mathematics, K-12 and Beyond* (pp. 81-94). Reston, Virginia: National Council of Teachers of Mathematics.

Marwine, A. (1989). Reflections on the Uses of Informal Writing. In Connolly & Vilardi (Eds.) .

Masingila, J. O., & Prus-Wisniowska, E. (1996). Developing and Assessing Mathematical Understanding in Calculus Through Writing. In P. C. Elliott (Ed.), *Communication in Mathematics, K-12 and Beyond* (pp. 95-104). Reston, Virginia: National Council of Teachers of Mathematics.

Powell, A. B., & Ramnauth, M. (1992). Beyond questions and answers: Prompting reflections and deepening understandings of mathematics using multiple-entry logs. *For the Learning of Mathematics, 12*(2), 12-18.

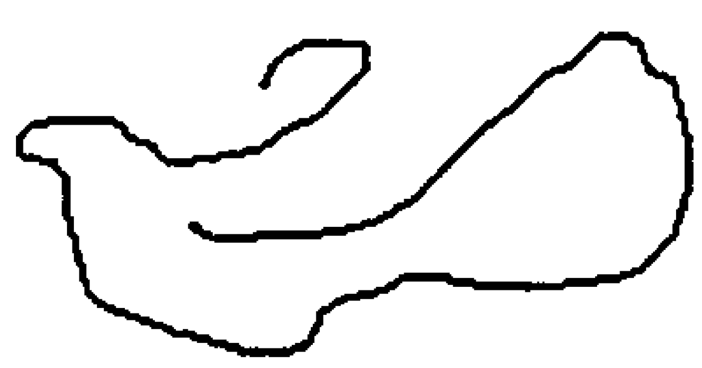
Shield, M., & Swinson, K. (1996). The Link Sheet: A communication aid for clarifying and developing mathematical ideas and processes. In P. C. Elliott & M. J. Kenny (Eds.), *Communication in Mathematics, K-12 and Beyond* (pp. 35-44). Reston, Virginia: National Council of Teachers of Mathematics.

Appendix 2: Pythagoras' theorem

Name ______________________ Date ______________

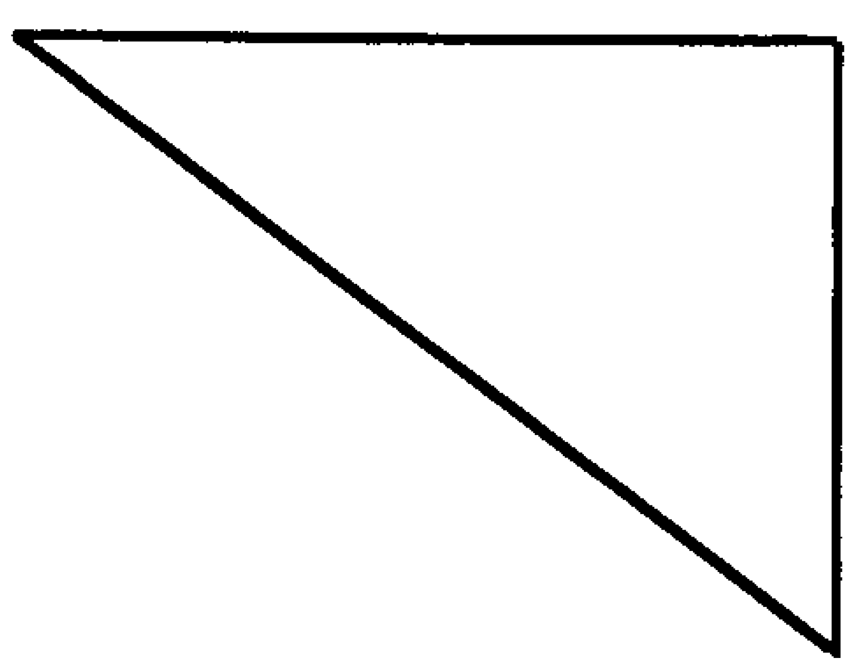
Pythagoras' theorem

This maths is named after Pythagoras, who spoke Greek
but probably studied in Egypt.
Many people in the world used this idea.
The ancient cultures of India, Babylon, China, Egypt,
Greece and northern Europe all used it.
No-one knows who discovered it.
This worksheet shows one way the theorem can be used
to make right-angled triangles.



Take a piece of string.
Use whatever units you want -
maybe feet, metres or the length of your own arm.
Mark the string into three sections, 3, 4 and 5 units long.

Now tie the ends of the string together.
Pull the points you marked,
so you pull the string into a triangle:



Which numbers work?

This is Lorenzo, an Argentinean building worker talking about how to make a right-angled corner:

'You put one stake here, another one there, right?

And this is the guiding one and that's it.

If you have 6 metres along here, you have 8 there,

it has to give you 10 here.

It's the same, 3, 4, 5.

It's logical, it can be 12, 16 and 20, right?'

How do you make a right angle in your own work?
It could be tailoring, dress-making, building, carpentry, farming.
Have you ever used a method like this yourself?
Or do you have other ways of doing it? Can you explain them?

Information from Juan Carlos Llorente, a researcher from Argentina (1997)

Piagetian Clinical Exploration: work-related activities of building workers with little schooling. In D. Coben (Ed.), *Adults Learning Mathematics - 3* (pp. 38-55). London: Goldsmiths College, University of London and ALM.

Appendix 3: Initial research leaflet

(A double-sided A4 sheet, folded to A5)

How about you?

You can be as involved as you like.
One thing you can do
is notice how you feel about writing and maths,
and either make a note of it,
or tell me or another student.
That way we will get new questions as we go along.
If you have any suggestions, or worries, about the research,
please let me know.
I want the project to be as democratic as possible.

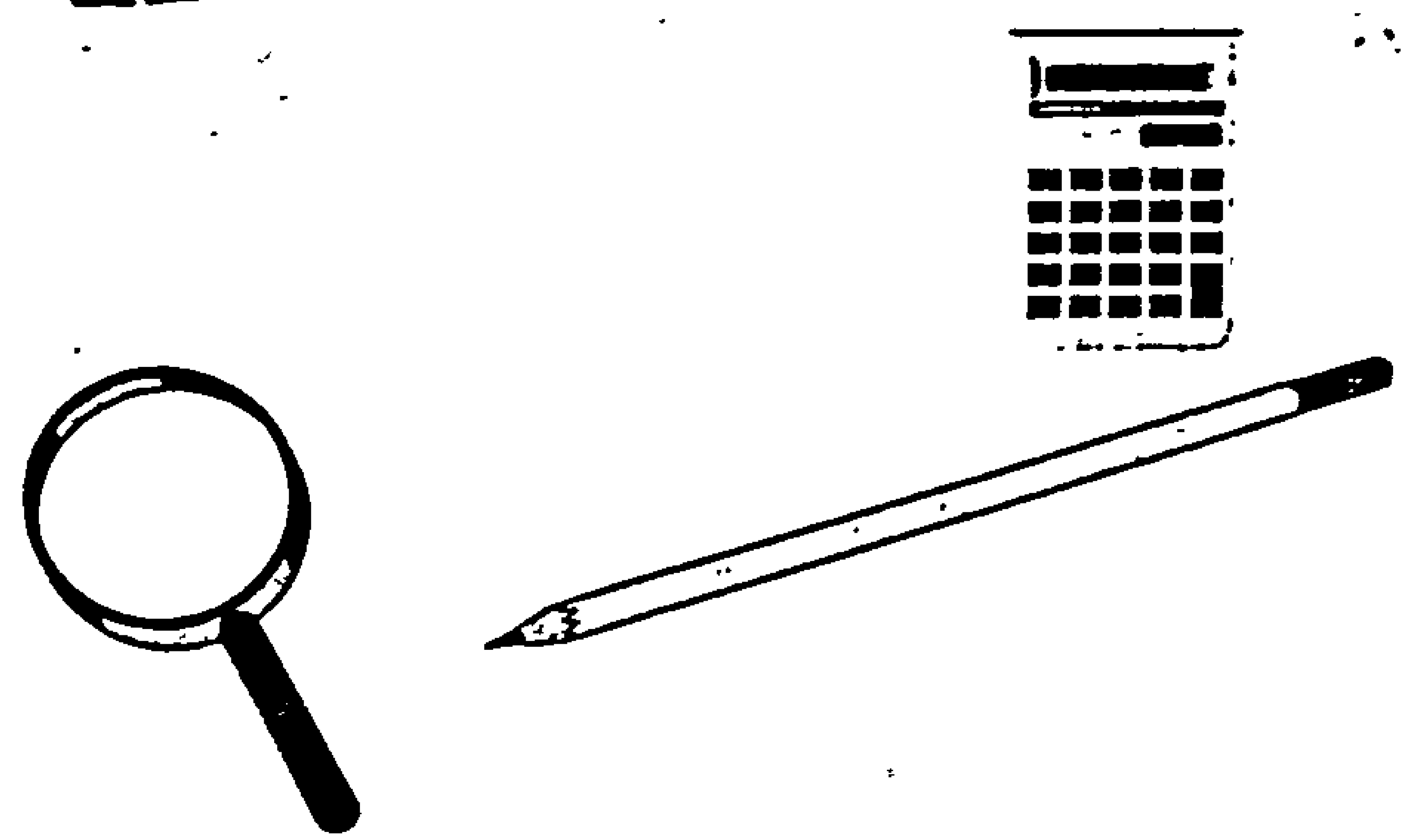
How long?

I will be studying this for three years,
and maybe longer.
In that time you may move,
or change classes,
or just lose interest in it.
Even if you leave classes after a few months,
you may have said or written interesting ideas
which we could use in the research.
So if you do move,
please let me know,
so that I can check with you before we write the final report.

How can this leaflet be improved?

I want to be sure everyone who reads this
knows what their rights are.
Please let me know if it could be better.

Writing in Maths Classes



Alison Tomlin
Post-graduate student, School of Education
King's College London
Cornwall House
Waterloo Road
London SE1 8TX
or leave a message at the Adare Centre, 0171926 6020
or the Strand Centre, 0171 926 7292/3

The research

I am asking questions about writing in maths groups
with adult students.

- does writing help you learning maths?
- what kind of writing helps you most?
- who is your writing for?
  yourself, the tutor, other students, or someone else?
- what happens if you have problems with reading or spelling?

I have only just started this work,
and the questions may change as we go along.
I don't know what it is like
being a student in basic education classes,
so I would like students to be researchers too.
Doing research means asking questions,
and you may have different questions from me.

Some of the things we may organise are:

- writing as part of your maths class
- making a magazine of writing about maths
- meeting with other students, from other centres,
  to share ideas and experience,
  and maybe make a magazine together
- interviews with students about what they think
- reading about what other students think
- making a pack of materials
  to help people think about maths and writing

Your rights

- If anyone wants to read your writing,
  I will let you know,
  and ask your permission first.
- I will take notes of things people say during the classes.
  But I will check with you
  before I use the notes in any writing of my own.
- If I interview you,
  I will make notes of what you said,
  and show you the notes before I use them.
  You will be able to change what you said
  if you want to.
- If you tell me you do not want to take part in the project,
  I will not use anything you have written or said about writing.
- I will use your name in anything I write
  if you want me to,
  or I will use a false name if you prefer that.
- We can make up new rules as we go along,
  because at the moment we don't know
  what issues may arise.

Appendix 4: Extract from a tape transcript, showing coding

This work is discussed in Chapter 6; the group's written work is in Appendix 6.
The 'notes' here were added when the tape was transcribed; coding is hand-written.

The following notes were given to group members when they read the transcript:

Times New Roman typeface indicates speaker is reading aloud from written text.
Other transcription notation from J. Potter and M. Wetherell (1987), *Discourse and Social Psychology: Beyond Attitudes and Behaviour* London: Sage.

(.) short pause [overlaps
(1) one second pause (3) 3 second pause
(words in brackets: not certain)
Underlined words are spoken with added emphasis.
[both laughing] words in square brackets are added by Alison.
= means there is no gap between the two people speaking.
: or :: extension of preceding vowel sound.

'it', 'they' etc

(coding originally in colour)

	Speaker		Notes
67	Dave spec/gen?	Yeah, er, basically, if you do criss cross on the hundred number window, you get the same answer, five 0 five, like, criss (.) you know like from 1 to a hundred, 91 to 10, and (.) if you are adding down like, 1 11 21 31 et cetera it goes up in 10s, the answers.	'lost' idea dir. adoption dir, clarify dir action action dir
	clarify	[Yeah? (.)	
68.	Alev	[Oh right, yeah, yeah	
69.	Dave	And also (2) there's (.)	Peering at worksheet
70.	Alison	There's a bit missing at the top left corner, isn't there.	auth: text?
71.	Dave	Yeah, that's the bit what's confusing me. It goes up in 100s (.) if you (.) [add along (.)	auth/org/text action dir
72.	Alison	[I think you said that's (.) adding sideways, is it?	direction clarify
73.	Dave	Yeah, I think if you add [across	dir
74.	Alison	action [1 plus 2 plus 3 plus 4	clarify
75.	Dave	Yeah (3)	
76.	Frank	(I reckon that's) 55. clarify	Reading the poor photocopy
77.	Dave later adoption 'end up in'	auth/text? math? auth/org Yeah. That's right, and then it's one five five, and then two five five, and then three five five. They all got fifty-five at the end (.) [chuckle in voice] You know what I mean? It goes up a hundred, but they're all these sort of like two five five, three five five, four five five, five five five. etc clarify	dir. clarify action (Another tutor comes in to borrow photocopy card)

78	Alison	Well (2) Shall we try thinking about why should it go up in fifty-five? [	auth/org
79	Dave	I mean (.) no it goes up in hundreds	naming nos
80	Alison	it goes up in hundreds, but they all end up with 55	auth/math adoption naming nos.
81	Dave	They always end up with 5s yeah.	adoption " "
82	Alison	Does everybody know what he's saying?	clarify
83	Dave	See at the top, these ones at the top	clarify, naming nos.
84	Alison	The first one you get 55	" "
85	Violet	Where is the actual one you did, where is the actual one that you did? auth/text org.	Violet wanted the original instead of the photocopy on which some numbers were not clear.
86	Dave	This is the 100 window, yeah?	clarify. Auth/org?/math?
87	Alev	They're going up in 5s	naming nos
88	Alison	No they're going up in 100s.	auth: math
89	Alev	Oh, 100s.	
90	Violet	Where is the original one you did?	
91	Dave	What do you mean? Oh, the original's in there. clarify auth/org	'in there' means in Dave's file.
92	Violet	Yeah, what's missing, if you bring it out?	auth/org/text?
93	Alison auth/org	Ok the numbers at the top that are missing are 55, um, 355, no, it's only 55 that's missing	auth/org. text
94	Dave 'lost' idea	It's only 55, yeah, that's right, all the rest are there, yeah. And it doesn't go above a thousand, like.(6) Like the last number's nine five five.	clarify action auth: math naming nos
95	Alison	So it's odd, you're saying, that it doesn't go =	clarify. Auth: org.
96	Dave	= Oh, yes it is a little bit odd. Like you know you don't reach a thousand, you think I don't know why, but (.)	
97	Alison adaption	Why should it, is it worth pursuing this question, why should they all end in 55 and why should it go up in 100s	auth/org
98	Dave auth: org/math	[Yeah, I think so, because um (1) I don't understand why it all ends in 5	naming nos
99	Alison	The first row is 55, yeah?	direction
100	Dave	Yeah ?	
101	Alison	Ok. →spec/gen?	
102	Violet	Mm hmm. Because if it's like that, it's in hundred grid, grids or grid or whatever, and it's in hundred, so if you've taken 55 it's like adding up, really. grid? Dave? we?	
103	Dave	Yeah	
104	Alison	Adding up what? auth/org/text	
105	Violet	Adding up hundred to whatever number you hold in hand, so each time it jumps up by hundred. Well, to me, that's the way I can =	spec/gen? naming nos action auth/math
106	Alison	= Why's it a hundred that it jumps up by? Why a hundred rather than 80, or 90, or 110?	[Joyce, Alev in background] auth/org/math. Adaption.
107	Violet	Because I feel that the whole thing is in (.) up to hundred grid [tapping on the grid with	visuals

naming nos? → adaption 130

auth/math

her finger]
108 Alison Yea:h?
109 Violet So (.) it's easier to add (.)
110 Alison Mm?
111 Violet in hundreds, rather than in 10s, or (1) in thousands.
112 Alison What were you saying, Dave? auth/org
113 Dave I think it goes up in hundreds because it's actually a hundred number grid, and I looked back at the base 10? spec/gen? dir. ?
auth/math
114 Alison Uh huh
115 Dave The thing I was doing, and I can't explain it, but there is some relevance between base 10 and this, like. I can't explain it, but (.) I think it goes up in hundreds because there's a hundred numbers. naming nos dir.
auth/math
116 Violet [laughing]
117 Dave From 1 to a hundred. naming nos.
118 Violet We, we, we almost there, but the (?), we don't quite. auth/math [interpreted as q. to teacher]
119 Alison Well, you, nothing that anybody's said is wrong, I don't think. It is to do with it being a hundred grid, and it is to do with it being base 10. I (2) It may be just different ways of thinking about it, what I'm thinking is, auth/math
you've got, if you look at the second row, naming nos. Dir.
you've got all the same numbers as you've got in the top row, haven't you, you've got 1 2 3 4 5 naming nos.
auth/math
120 Violet Up to 10
121 Dave Yeah, and then it's 10 apart all the time dir auth/math
122 Alison Yeah, and then the next row down, each square below has got 10 more. dir naming nos. dir.
123 Violet Yeah
124 Alison So 11 is 10 more than 1, and
[12 is 10 more than 2
125 Dave and they've all got
126 Violet [So if you add all of that
127 Alison So you've got 10 lots of 10 (.) more.
128 Dave Yeah, yeah, that's right, yeah, yeah.
129 Alison Make sense?
clarify
130 Violet So you go through 10 lines, you get hundred. dir. action. naming nos.
131 Alison So altogether you get a hundred on the whole thing, but each box you've got 10 more (than what?) naming nos. adoption naming nos
132 Frank You've got ten more extra = adoption
133 Alison if you're comparing the second line to the top line. dir/naming nos.
clarify
134 Violet Yeah, yeah, I'm with you.
135 Frank Is it ten more extra?
136 Alison Yeah, I think so.
137 Violet Ten more extra for ten lines it comes out to hundred for each line.
138 Joyce Each line, because that's 20, and that's 30, so that's ten more, that's another ten for each. [Looking at the ends of the rows] visuals
dir auth/math
139 Dave Well if you imagine the 1 as being a nought

		say, just say it was a nought, and the 11 was a 10, and the 21 was a 20, and the 31 was a 30 (.)	auth/math clarify
140	Alison	It's more obvious ↑ (clarify)	
141	Dave	Yeah, it's more obvious, it's going up in 10s, from, like, 1 to 11, which, that's what (.) the same as base 10 is, isn't it? Start off with the 1, like.	adoption clarify auth/math auth/math
142	Alison	Are you agreeing with this, Yvonne? You're looking faintly (.) [sceptical.	auth/org /math (Y) visuals
143	Yvonne	[Yes	
144	Dave	[laughs]	
145	Alison	Alright, alright, Yvonne's agreeing. Are you agreeing, Samina?	auth/org /math (S)
146	Samina	Mm	
147	Alison	Yeah? Alright.	auth/org
148	Dave	Oh, I'm glad about that!	auth/math (gp)
149	Alison auth/org	Alright then, shall we try somebody else's then? (3) Um, who shall we do next? (10) Shall we try Frank's? (4) Have you got yours there, Frank? Yep, this one. (4)	Rustling noises

Appendix 5: Observation schedules

Classroom Observation

25.3.98 - 4.3.98

Teacher / Student Interaction:

Item	Scale (left)	Scale (middle)	Scale (right)
Teacher spends most time talking to:	inds	gps	class
Teacher is friendly to students	always		never
Teacher asks qus which are answered by	recall of facts		process
Teacher offers support to students by	structuring problem		asking qu's
Teacher attitude is	authoritarian		liberal
Teacher stance with relation to students	distant		close
Teacher sits at desk	often		never
Teacher praises / encourages students	often		never
Teacher is sensitive to the needs of students	often		never
Teacher talks at / talks with students	talks at		talks with
Teacher asks questions which have:	one answer		many answers
Teacher encourages communication and negotiation	often		never
Teacher is a dominant figure in the classroom	agree		disagree
Teacher's interactions with pupils are	open		closed
Teacher treats girls and boys	the same		differently

Students

25.2.98 – 4.3.98

Students have a sense of purpose	agree	disagree
Students are excited by their work	most	none
Students are	quiet	noisy
Students move about the room	frequently	never
Students discuss mathematics with each other	frequently	never
Students initiate talk with the teacher	frequently	never
Students talk to the teacher in order to	negotiate	seek answers
Students freely investigate & explore	agree	disagree
Students try and finish before each other	agree	disagree
Students are motivated	agree	disagree
Students seek guidance on:	process	content
Students understand the teacher	agree	disagree
Students wait for the teacher before moving on to new areas	agree	disagree
Students are encouraged to express their own views of mathematics	agree	disagree

Who asks the questions?

	Questions to the whole group	Questions to women	Questions to men
Tutor's questions to students Genuine question - wanting to know the answer	✓	✓✓✓✓✓✓✓✓	✓✓✓✓ ✓✓
A question to find out if the student knows something.		✓✓	✓✓✓✓✓✓✓ ✓✓✓✓
A question to help the student work something out.		✓✓✓	✓✓✓✓ ✓✓
Other sorts of questions	✓✓✓		✓✓✓
	4	13	26

Students' questions

Names→	Carol	ANDY	Huusa	Trevor's	Priya	Joyce	
Students' questions to the tutor Checking what the tutor wants them to work on, or checking what the task is.	✓		✓	✓	✓	✓	
Stuck and wanting help.	✓	✓		✓			
Wanting factual information - for example, checking whether an answer is right.			✓				
Students' questions to each other Checking what the tutor wants them to work on, or checking what the task is.	✓	✓	✓ ✓ ✓	✓			
Stuck and wanting help.				✓			
Wanting factual information - for example, checking whether an answer is right.							
Other sorts of questions ..		✓	✓				

Who does the talking?

Names →	ANDY	ALISON	PRIYA	TREVOR	Thomas	Carol	Joyce	
Talking to whole class		III		I	I	I		
Talking in a small group or a pair	II IIII			II	I III IIIII	I IIII I IIIII	IIIIII	
(Students) Talking to the tutor	I III	IIIIII	II IIII	IIII II	II		I	
	10	9	6	9	12	12	7	

How do we spend the time?

	Settling in	Tea break	Individual work	Small group or pairs work	Whole group together - tutor teaching from the front.	Whole group discussion	Record-keeping.	Sorting out homework	Other.
6.50 pm									
7.00									
7.10									
7.20									
7.30			✓	✓	✓				
7.40			✓		✓				
7.50			✓						
8 pm		✓	✓✓						
8.10			✓	✓					
8.20			✓	✓					
8.30			✓	✓		✓			
8.40			✓		✓				
8.50				✓	✓				
9.00							✓		
			9	4	6				

The Wednesday evening maths group:

Collecting Data

Participating students: Andy, Carol, Joyce, Priya, Trevor, Theresa.

We all observed the group for two evenings. Joyce was absent one evening so she is under-recorded in the data. We shared out the different tally sheets between us, and if we did two we did a different one the second time. Four of the students collated the information onto single sheets, and reported back to the group.

Summary sheets are attached. They are the sheets for two evenings combined into one.

- A summary of the findings of the tally sheets.
- How do we spend the time?
- Teacher/Student Interaction.
- Students

You may want to take the study further.
These are some ideas:

- What picture of the group do you get from the data?
Does anything surprise you, or is it much as you expected?

- From looking at the data,
is there anything you think we should change
in the way we run the group?

- Do you think the data gives an accurate picture of the group?

- Did you enjoy doing the observations? Why, or why not?

Appendix 6: Students' work on the 100 grid

Name DAVE Date ~~13.~~ 14.5.97

Number grid investigation 10 x 10

1	2	3	4	5	6	7	8	9	10
11	12	13	14	15	16	17	18	19	20
21	22	23	24	25	26	27	28	29	30
31	32	33	34	35	36	37	38	39	40
41	42	43	44	45	46	47	48	49	50
51	52	53	54	55	56	57	58	59	60
61	62	63	64	65	66	67	68	69	70
71	72	73	74	75	76	77	78	79	80
81	82	83	84	85	86	87	88	89	90
91	92	93	94	95	96	97	98	99	100

What happens when you add the numbers in the windows?
Can you find any patterns?
Does it matter where the window is?
What happens if you change the shape of the window?

Investigate ...

Extensions:
What happens if the grid is not 10 x 10, but 7x7, or 4x4?
Try other grids. 7x7 Grid.

Ans go up in 14
Ans 2 apart
Ans CHRISS cross, the Same in 4 number window

Some useful words for your notes:

Stuck!	Aha!	My mistake was ...
Then I tried ...		I wonder if ...
It doesn't work because ...		It works because ....
I don't know why ...		

9 apart.
52 53
62 63
11 apart

The Grids are Sqauered; 10^2
in the 4 number Window
If you add criss cross you get the same answer
If you add across straight The answers go up in 20
If you add Down the ans are 2 apart, and also the numbers going down 'go up in 10s'

it doesn't matter where the 4 windows are, they have similar patterns as above.

if you.

If you change the shape of the window to a 9 number window
CHRISS cross The Ans are the Same
Accros horizontaly, Ans go up in 30s
Down straight. Ans go up in 3s.

16 window
Chriss cross Ans are Sam
Across horizontaly Ans go up in 40s
And Down straight Ans go up in 4s.

ALSO
9 apart
1 2
11 12
11 apart

In all the 4 window 9. 16 25. 36 to the 100 window

155 455 755
255 555 855
355 655 955

100 number window

DAVE

1	2	3	4	5	6	7	8	9	10
11	12	13	14	15	16	17	18	19	20
21	22	23	24	25	26	27	28	29	30
31	32	33	34	35	36	37	38	39	40
41	42	43	44	45	46	47	48	49	50
51	52	53	54	55	56	57	58	59	60
61	62	63	64	65	66	67	68	69	70
71	72	73	74	75	76	77	78	79	80
81	82	83	84	85	86	87	88	89	90
91	92	93	94	95	96	97	98	99	100

1 + 12 + 23 + 34 + 45 + 56 + 67 + 78 + 89 + 100 = 505 } THE SAME
91 + 82 + 73 + 64 + 55 + 46 + 37 + 28 + 19 + 10 = 505 }

1 + 11 + 21 + 31 + 41 + 51 + 61 + 71 + 81 + 91 = 460
2 + 12 + 22 + 32 + 42 + 52 + 62 + 72 + 82 + 92 = 470 up in 10s
3 + 13 + 23 + 33 + 43 + 53 + 63 + 73 + 83 + 93 = 480
4 + 14 + 24 + 34 + 44 + 54 + 64 + 74 + 84 + 94 = 490
5 + 15 + 25 + 35 + 45 + 55 + 65 + 75 85 + 95 = 500
6 + 16 + 26 + 36 + 46 + 56 + 66 + 76 + 86 + 96 = 510

520
630

YVONNE

1	2	3	4	5	6	7	8	9	10
11	12	13	14	15	16	17	18	19	20
21	22	23	24	25	26	27	28	29	30
31	32	33	34	35	36	37	38	39	40
41	42	43	44	45	46	47	48	49	50
51	52	53	54	55	56	57	58	59	60
61	62	63	64	65	66	67	68	69	70
71	72	73	74	75	76	77	78	79	80
81	82	83	84	85	86	87	88	89	90
91	92	93	94	95	96	97	98	99	100

each row across jumps up by 100.

WRONG each column ~~row~~ down jumps up by 90*.

WRONG across ↘↙↗ jumps up by 90.

1	2	3	4	5
6	7	8	9	10
11	12	13	14	15
16	17	18	19	20

6 is 5 more than 1

11 is 5 more than 6.

1 2 3
4 5 6
7 8 9

4 is 3 more than 1

7 is 3 more than 4

each number down is 10 more than the number above it

If you change the grid the number in the right hand corner is the number the numbers below are greater than beginning with one.

FRANK

158 69 70 / 79 80 150 | 180 82 83 / 92 93 185

181 85 86 / 95 96 ~~176~~ 181 | 188 89 90 / 99 100 190

85 86 / 95 96 — 86 + 95 = 181 — 85 + 96 = 181

~~82 + 92 = 174~~ ~~83 + 93 = 176~~ + 81 + 91 = 172 + 82 + 92 = 174 + 84 + 94 = 178 + 85 + 95 = 180

Each sum is different one after the other. Starting from the lowest number and adding up to the highest numbers. When you add them in a ~~straigh~~ straight. column line each ~~number~~ column line add up differently. Because each row adds up by ~~two~~ ten. To give the answer.

. They are 2 apart, because each column is one more than the column before.

Appendix 7: Empty Number Line worksheet

Name ______________________________ Date _______________

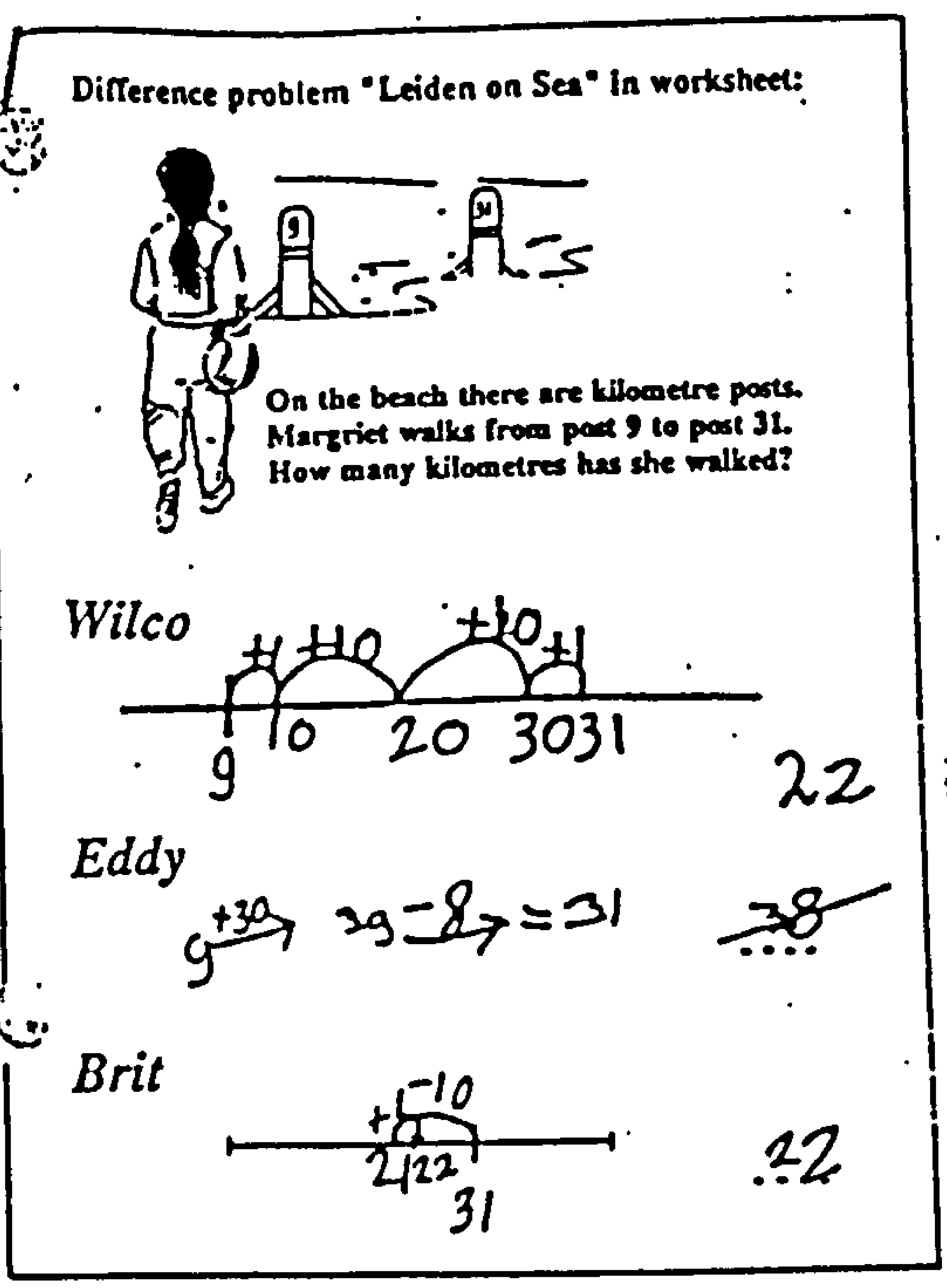
The Empty Number Line

Some maths teachers in the Netherlands
have started using the *Empty Number Line*
to help people with mental calculations.

You draw your own line, as long as you want,
and put your own numbers on it wherever you need them.

This is an example of three people's work on the same problem.
You can see they do it different ways.

(What looks like a letter g is a number 9.)



Three solutions of pupils Wilco, Eddy and Brit in worksheet.

Make up some problems
and try using an empty number line.

The line can be used for adding
and taking away.

Can you find a way to use it for
division or multiplication?

Compare your work
with someone else.
Did you find different ways of solving
the problems?

And finally ...Do you think the empty number line might be useful for you?
How did it work out? Would you recommend other people to try it?
Please put your comments here:

....

....

....

....

Information from Beishuizen, M., & Anghileri, J. (1998). Which mental strategies in the early number curriculum?
A comparison of British ideas and Dutch views, *King's College London* AT

Appendix 8: Extracts from classroom text on fractions

Name ______________________ AT/LCE/95

Fractions Part 1

Based on the chapter on fractions in
Marilyn Frankenstein's book Relearning Mathematics. The Third R - Radical Maths,
published by Free Association Books.
Some of the examples have been changed, using information from
Labour Research and Michael Tintner's State Imperfect.

LAMBETH EDUCATION

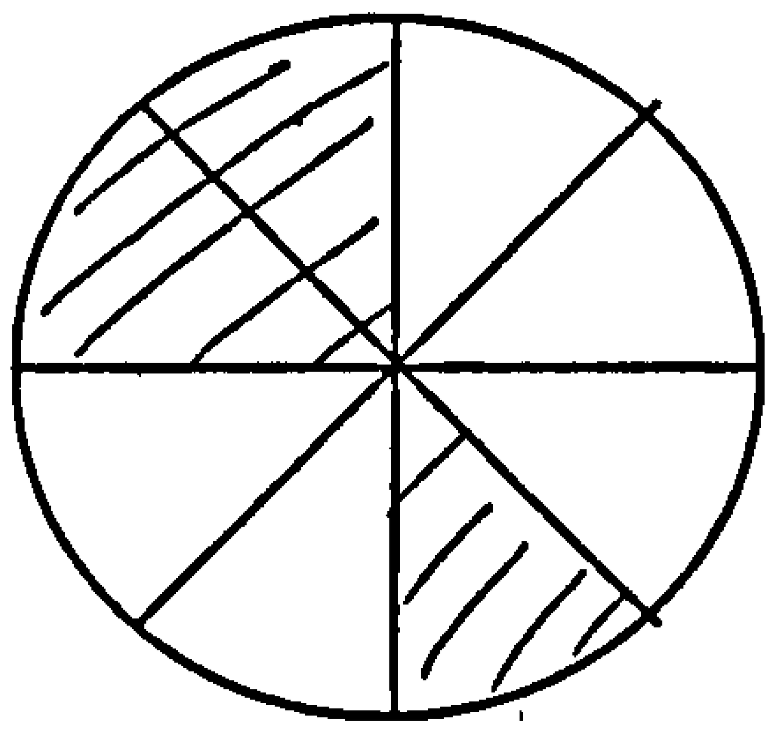
Note: this word processor will not write fractions easily! When writing fractions by hand, you can put them as $3/4$ or $\frac{3}{4}$

In this work, 'Solved problems' are problems that someone else has already solved. They are to give you examples of how to do the work. 'You try this' means it's not solved for you. Answers are at the end.

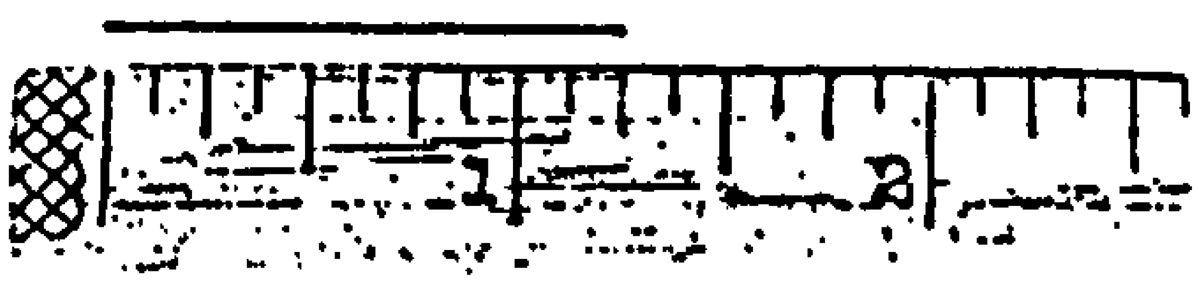
Fractions have more than one meaning.

1. Parts of a whole.

In this diagram, 3/8 of the circle is shaded. It is cut into 8 pieces. The 8 in 3/8 is the number of pieces (the denominator) and the 3 in 3/8 is the number of pieces shaded (the numerator).



This line is more than one inch, but less than two inches long; it is 1 1/4".



2. Comparisons between groups.

In 1989 out of 650 MPs (Members of Parliament), only 42 were women. You can write this as a fraction:

$$\frac{42}{650}$$

3. Fractions can be used to represent division

Suppose you want to share 4 cakes equally between 3 people. Here are three ways of writing the division: $4 \div 3$ $\quad 3\overline{)4}$ $\quad \frac{4}{3}$

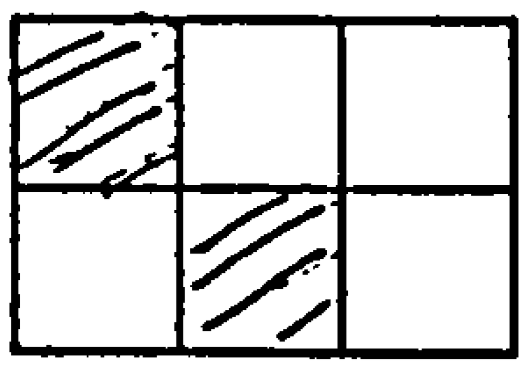
Each person would get this much:

p. 1

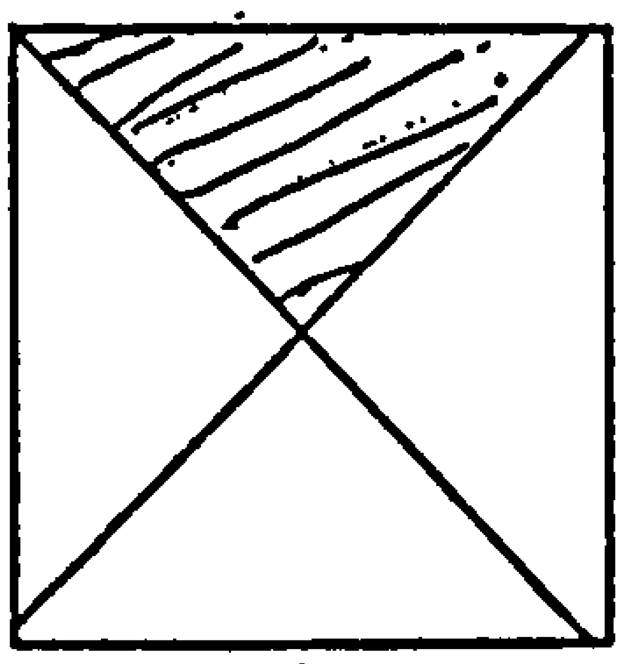
Problem 10

Someone has solved this problem and made mistakes. What is the error pattern?

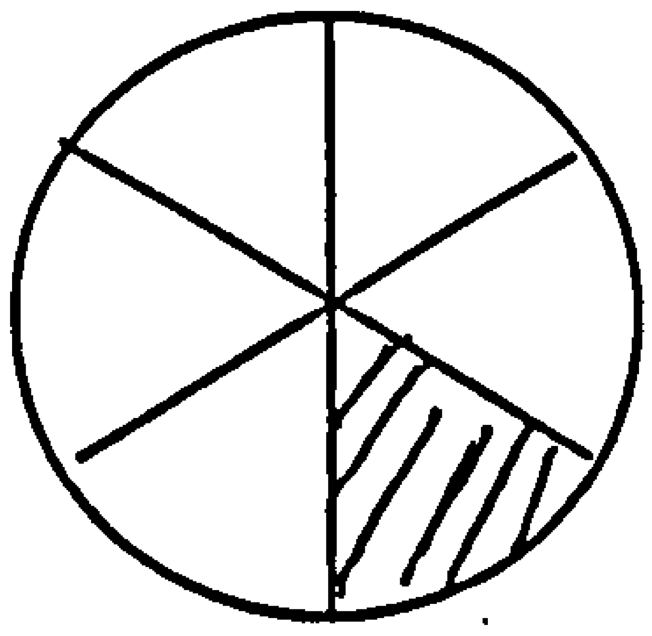
The problem was:
Name the fraction which represents the shaded part of each diagram:



$\frac{2}{4}$



$\frac{1}{3}$



$\frac{1}{5}$

Problem 11
Create a five question quiz that reviews what you have learned in this chapter.

Problem 12

Britain's immigration laws.
At the time of writing (November 1995) immigration and asylum laws in Britain are about to be tightened up again.

In 1987, in each million inhabitants, there were 80 people seeking asylum in the UK.
Other countries had far more:

Sweden	1 598
Denmark	1 456
Switzerland	1 333
West Germany	1 117
Austria	988

Summarise the main point, and rewrite the numbers as fractions.

Problem 13
In London, over 1000 women a week phone the police about domestic violence. In one Yorkshire community, 129 women were interviewed, and 77 of them reported threats or violence against them. What fraction is that?

Problem 14
Britain has 12 species of reptiles and amphibians. Four species are in danger of extinction. What fraction of reptiles and amphibians may die out?

p. 8

Appendix 9: Meeting for Maths Students for Beginners

A conference for maths students?

Get involved!
Help organise a meeting
for maths students to get together

I hope to organise a conference
for people in adult maths classes.
It could be in the summer term
1997,
or the autumn term.

What use is a conference?
I am working with maths students as a tutor,
and as a researcher.
I am looking into whether writing can help people
learn maths.
A conference would mean
that students could meet each other
and share ideas.

But we don't have to talk only about writing
in maths classes.
These are some of the things we could talk about:

- how could your maths classes be improved?
- are all education centres the same?
- what kinds of maths do you enjoy?
- we could also do some maths at the conference
- we might be able to make a magazine about maths.

Planning the conference ...
I would like other people to be involved in it.
We need to decide ...

- the venue
- the date
- what topics to discuss
- how to organise the discussions
- how to advertise the conference

... and probably much more.

Interested?
If you would like to join a conference planning group please let me know.
I might be able to pay your travel expenses, but there will be no other payment.
You can be involved as much or as little as you like.
These are some of the things we might do:

- look at venues and check whether they are suitable
- work out a budget for the conference
- design a programme, and decide whether we need people to help lead the discussions
- decide who to invite
- design an advert for the conference, and distribute it
- organise a creche
- organise interpreters if people need it.

Don't worry if you have never done this sort of thing before - we can work it out as we go along.
And you don't need to be good at reading, writing or spelling.

Contact
Alison Tomlin, care of one of these education centres:
Adare Centre, 0171 926 6020
Strand Centre, 0171 926 7292/3
Bede Education Centre, 0171 237 3881
If you leave this reply slip at one of the centres, I will get in touch with you.

Thank you!

✂...

Name ....

Education Centre ....

If you do not mind being contacted at home,

please give your address and telephone number

Address..

....

Telephone ....

MEMORANDAM

Bring in your own piece of work that you have done with Alison, you may also need to use some of your work for the display.

There will be about 30-40 people coming, so that will mean that we will have to be divided into small groups.

Alison will make a small introduction.
All of the students will stand up and introduce themselves, then next Sandra and Shazia will make a small speech, representing the collage.

Each of us will spread out and form a group. We will then talk to our groups asking questions and perhaps taking notes.

At 2.30 Tracy will call everyone into the large hall.

We will then discuss altogether the information that we have collected and share this with all the others as a whole.

Claire is to make a final statement, she will also mention the newsletter..

Alison will be busy trying to make a small magazine together.

Appendix 10: *Global Maths*

The front cover of *Global Maths* was printed on A4 yellow card: it is copied on this page, reduced in size. This appendix is double-sided to reflect the magazine's format. The magazine's original page-numbering (bottom centre of the page) is retained, and is the numbering used for references to *Global Maths* in the thesis. To make the appendix consistent with the thesis as a whole, hand-written page numbers have been added.

Contents

INTRODUCTION

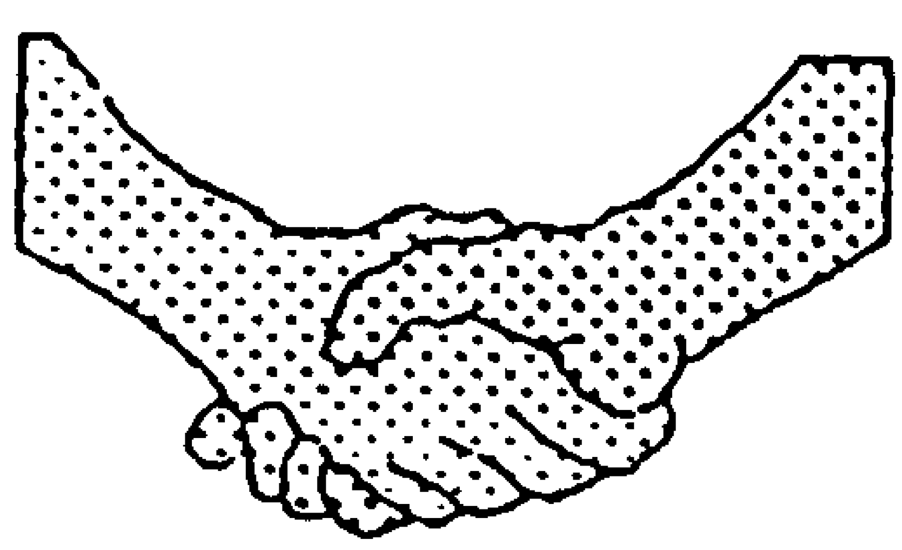
Thanks to Alison, who had an idea to create a maths conference, which by the way went excellently well, we then decided the idea that we should take the maths conference further and to now produce a maths magazine. The students thought that it would be a good idea to expand this maths conference, because it was a great success. We had no idea that students from other colleges and also tutors would share opinions, same or different. We have exchanged views and are now aware that maths is good to talk about. We have made many friends from other Colleges, of all ages and different cultural backgrounds. Altogether there was a lot of information gathered.

We the students would like to take maths further than the first conference, and would like to present you with this magazine. We hope that there would be another maths conference in the near future.

We would like to thank everybody who supported us and took part in producing this magazine.

This magazine is dedicated to Bede Education Centre,
who provided us with their excellent service, advice,
equipment, quality time and patience.

Shazia, on behalf of the newsletter group.
November 1997



For more copies of the magazine please contact
The Maths Newsletter Group, Bede Education Centre,
351 Southwark Park Road, London SE16 2JW

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Students' Meeting

The conference went great. We would like to thank everybody who came and hope to see you at the next one. This is the first time something like this has ever taken place.

Everyone agrees that maths is important, we need it in everyday life from checking our change to paying our bills. We also found that the way of teaching has changed a lot, as well, a good student teacher relationship is essential.

Some people were saying that when they were at school, that if they couldn't do a sum or answer a question properly that they would get the cane, so under all the pressure and embarrassment they had trouble learning.

We also found that fractions and decimals are such a common problem. It's great knowing you're not the only one who can't reduce a fraction off hand. The atmosphere was great; every one got on great as well. We had a lot in common as well apart from maths.

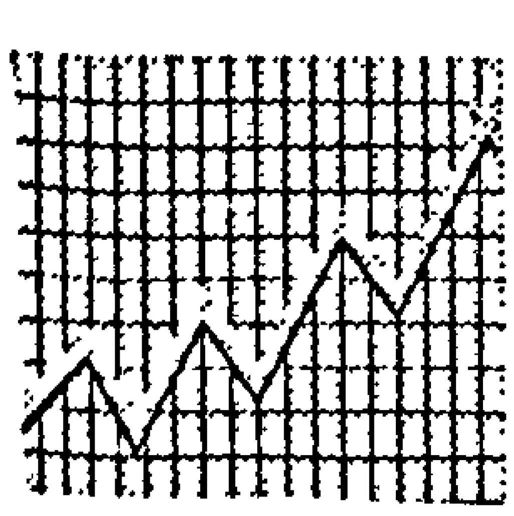
When I knew the were tutors coming I started to panic but they listened to us and heard our ideas and thoughts.

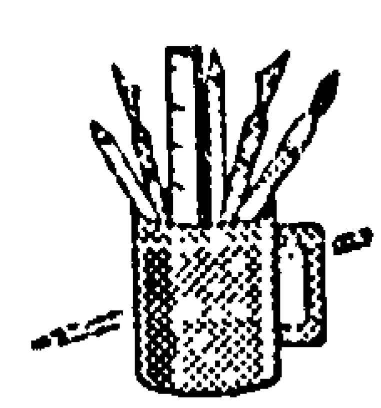
Most people came back to study after having children others to get refreshed for a new or higher career.

We also spoke about how we like learning. We agreed that both textbook learning and group learning were important. We like learning about who invented maths, where it came from and how maths has developed over the years. Maths is taught so differently in some countries, which is important for us to know.

People's learning problems were discussed as well, such as dyslexia. Dyslexia is widely recognised now, but not so long before you were branded a dunce and other things, which make you self-confidence, take a turn for the worse.

Bullying was also a large topic. You can get bullied for being either clever or not so clever and this again does not help at all.





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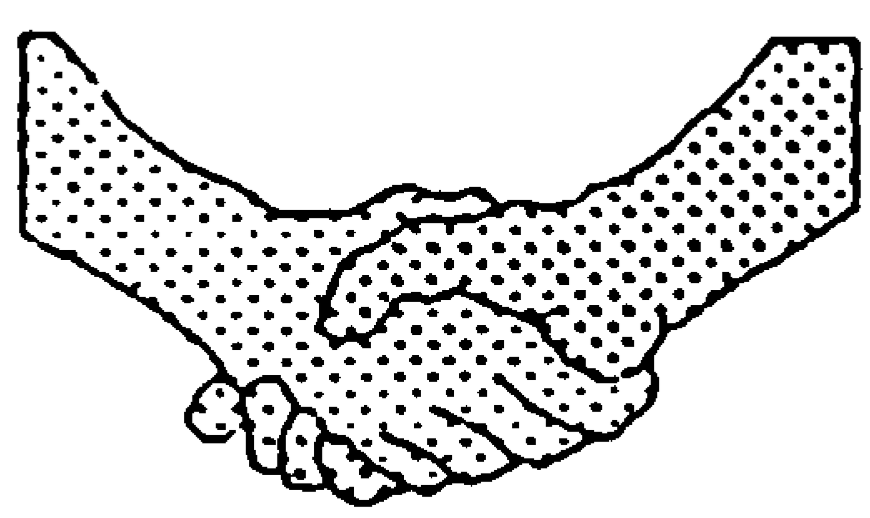
We had a list of questions to ask, but with the atmosphere there the questions just seemed to flow, so quick in fact I could not write most of them down.

Students were also keen to know about Bede House and other colleges.

At the beginning we were able to have food and wine which was lovely and helped us to mingle. At the end we exchanged views and opinions. For a first time, I think the meeting was a success.

Tracy ON THE BEHALF OF BEDE STUDENTS



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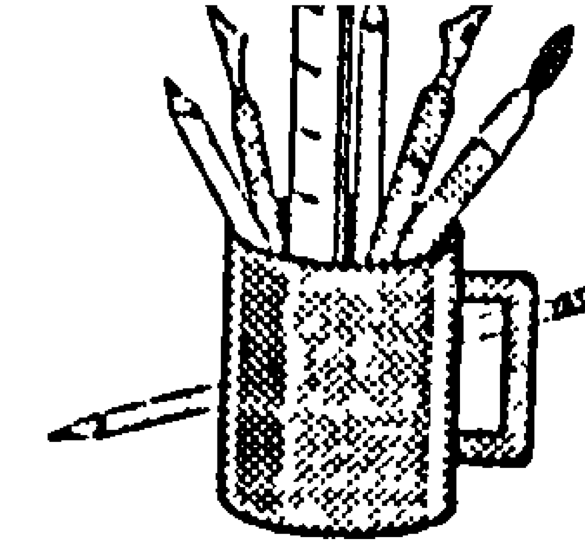
Writing about the conference



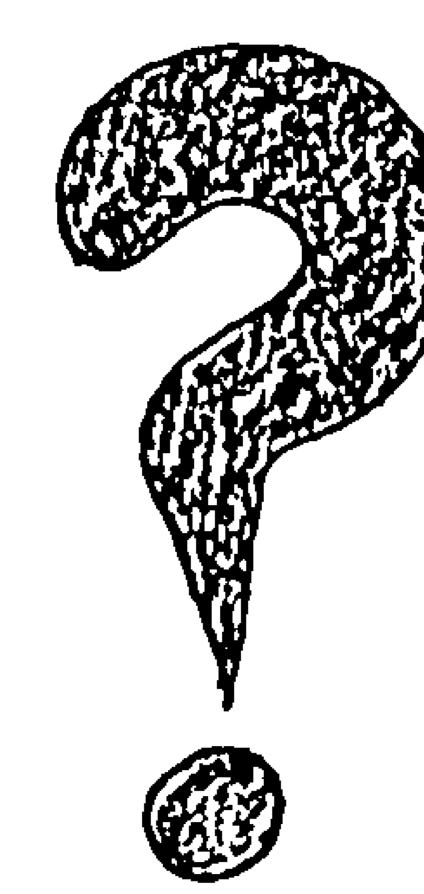
Shazia

Maths Conference Statement

I found that the meeting went really well. I really did not expect so many people. I truly thought that everything would go wrong. I could not sleep that night. Although it was a slow start to get our organisers prepared, everything was perfectly in order. It seemed like a slow start but it only took us half an hour to get everything ready.

The students started to arrive and I started to panic. I already threw my speech away while altering my life. That's a good start. The photocopying machine didn't like me, but thanks to Sue we managed to have the photocopying done.

I'm glad that Sue, Tony and Ann could make it to the conference, I felt comfortable.



I did not know that there would be a load of tutors from the other parts would also attend the meeting, but I was ok with it.

In my group there was about ten or more people. The group I was working with were great, we covered most of the aspects in our little survey that we did.

My group was getting larger as the tutors were late, this was because they had difficulties in finding the place. I thought it would be a good idea to leave my colleagues Jeremy and Antoinette to stay with the 1st group while I go with the next new group.

I thought this was appropriate because I felt that the new arrivals needed a bit of an explanation to what we had already discussed. I didn't want to start asking the same questions again because I thought it might slow things down, and we didn't have enough time.

To my amazement I was quite astonished to find that we had similar ideas and thoughts. And some people yet thought so differently.

There was a lovely sort of atmosphere, and warmth. It was as though we all knew each other.

The students were very keen to know about Bede House, what this organisation does.

They thought the food was great and were very surprised when I told

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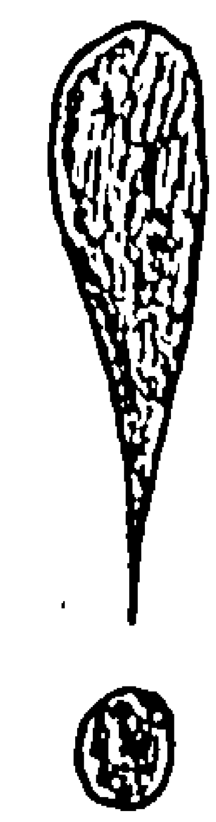
them that one of the trainees did the cooking.

They also mentioned how beautiful the area was, with all the greenery around us.

Some of the students already wanted to know when the next meeting was, and also wanted to know when the newsletter will be published.

In all it was a great day. The thing that I liked most was at the very end when we exchanged views. I had no idea they were taking notes about our discussion.



I think that for the first time, this meeting was a great success!

I would love to do this again, and maybe we could expand it to other colleges.

Some of the students found it hard, but got the hand of it during time.

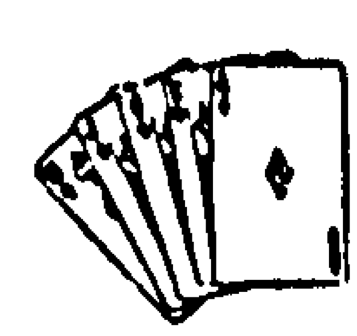
Most went back to studying after having children. And also to prove to their children that school does not stop after secondary school.

Some wanted a challenge, and wanted to take maths because they were afraid of it earlier before their age.

They got a lot of encouragement from their tutors. They are not afraid to do exams because of mocks. They like maths exams where you have to tick the correct answer.

Most did not like the fractions, long division and %. They like working at their own pace, but when it comes to children, they would prefer their children not to slack off and would worry if there were any problems.

The younger students wanted to go back to college and study with their own age, because they thought that school was fun and that any student would love to study as an adult at college, and take their work seriously.



Teachers should set a good standard in teaching, and must have time and patience.

It is hard when there are large classrooms, therefore there should be a good ratio.

Also it is also a question of being pressured. Some of us found it difficult to ask too many questions, and sometimes felt pressured when

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having problems with work. They felt that they were slowing the others down.

So this is why some like to work in a group and some individually and some both.

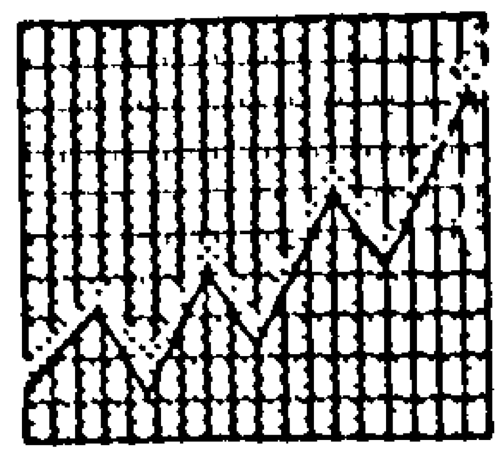
It was also a bit embarrassing when some were older than the others, or younger. Some got used to the idea, some felt that they were too late to start again.

Again some were very confident in thinking that it is never too late to learn.

There were all different ideas about why people want to do maths.

Some wanted to face up to maths.
Some needed a hobby.
Some for children.
Some for a job.
Everybody agreed that maths is important to us, on a day to day basis.
Education is very strict in foreign countries.
Discussed the history of maths.

Students like both textbooks and working like Alison.



Lorraine

I really enjoyed the maths conference.

There were six people in our group, and each of us in turn spoke about how we found maths. I get all tongue tied when I have to make a speech but I felt quite confident. There were so many ways to answer maths questions, and different maths to work out. We had different problems with different maths, e.g. percentages, fractions. I have just taken a City & Guilds Stage 2 exam. I am waiting for the result.

I would like to say a big thank you to everyone that has in any way helped me with my maths work.

14.7.97

Mario
Notes from discussion group

Many different ways to do maths.
Lambeth Accord do testing for dyslexia.

Litres

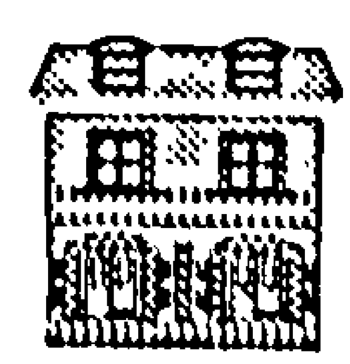
Tutor's approach is important.
Most students want both text and everyday learning.
Adults have more sensible/less shy approach.
Some adults still shy.
Age barriers among students negate learning.
Tutors get paid to teach, yet often, students don't benefit and don't feel entitled to being taught /shown things.
Test taking techniques very helpful.
Personal responsibility (adult leavers), and adult responsibility for children's education.
Some parents may "not seem to care" but some do try (personally or through centres) to help children with school work.
Fractions are now more important in accounting than they used to be (Jeremy).
Make it fun; half the argument against maths disappears.

Our group
Bede: Shazia, Antoinette
Brixton students: Charles, Janet among others
CAVE students: Donna, Vida, Aston, and Marcel, who came later.
CAVE tutors: Sheila and Mario.
Southwark College student: Jeremy.

Sandra
Notes from discussion group.

Generally people thought the same about maths.

1. When young, maths was hard and you got punishment. In adulthood it is made easier because there is no pressure. Places you could go where help is available. Tutors knew what you were going through.



2. Maths helps you get a job, helps with your shopping, measurement, your money, i.e. bills, and if you have children you now can help them.

3. People wanted to improve their maths work, i.e. sit exams and catch up with lost years.

4. They talked about the inventors who discovered maths and found it interesting.

5. Some people have problems, like dyslexia, or did not go to school very often, or because they were the eldest, go one day and then not for a long time and then go another day. So they did not learn much at school.

6. Everyone agrees to work out the sum first then check it with your calculator, because some were afraid they would touch the wrong button, or it would take a long time to work.

7. Exams. People felt we should have more practice with exams in the classroom.

8. People felt they have to have a good tutor, but sometimes they can have conflict. In the classroom some people can work as a class and others left by themselves.

SUMMARY
It was a good turn out and Alison was pleased things went well. Found out how other people work with maths and got taught as a child. Everyone really enjoyed the meeting. People read pieces of their own work and did well. Groups all had something to say. Thank you Alison and fellow students.

Tracy
Notes by Tracy with additional notes by Ann.

1. *Do you like maths?*
Yes. It's fun and challenging.

2. *Was maths an easy or hard subject for you at school, and if it was, why?*
Hard at school because of the fear of being beaten puts you off. Bullying from others e.g. if too good or bad.

3. *Why do you do maths? Is it to help you get a job or perhaps to help your children with their homework?*
To help ourselves and our children, also because times are changing. Enjoyment. Hobby.

4. *What are you most weak at in maths?*
Fractions, decimals are found to be the hardest. Reading maths is hard but writing maths is very useful.

5. *How much further would you like to be educated in maths?*
As high as possible, but even then we will still find problems. There is no end to what you can learn.

6. *Would you be interested in the inventors who discovered maths?*
Yes some of us have already learnt some things about this.

7. *How much important is it to you, to learn maths?*
Very important, for every day use such as buying a home, working out

Litres

the interest, also shopping, paying bills.

8. Do you think that maths is all to do with knowing how to do sums or is it all to do with working things out in your own way?
No, it's everyday use from buying a home to paying a bill. It's also about sums but maths is everywhere, wherever you go.

9. Would you like to know if there are more than one way in solving a maths question or puzzle?
Yes.

Are you afraid of exams?
Not really but the thought of exams scares everybody, and with this when you sit down you forget everything. You feel to stay in a group with friends you have to pass.

ml

Do you think it is all down to a good tutor to improve your maths?
If it's a good tutor then you're ok because it is down to the tutor and how relaxed you are with him/her.

Do you think it would be easy for you to learn things by heart or by practising as much as you can?
By practising again and again. Even our time tables we know before but don't know them now.

Adult education is important. You may find as you get older things get harder to grasp than when you were younger.

Jeremy
Notes from the discussion group.

Figures; fractions; percentage.

mm

There needs to be a good tutor student relationship. This will improve the learning process.

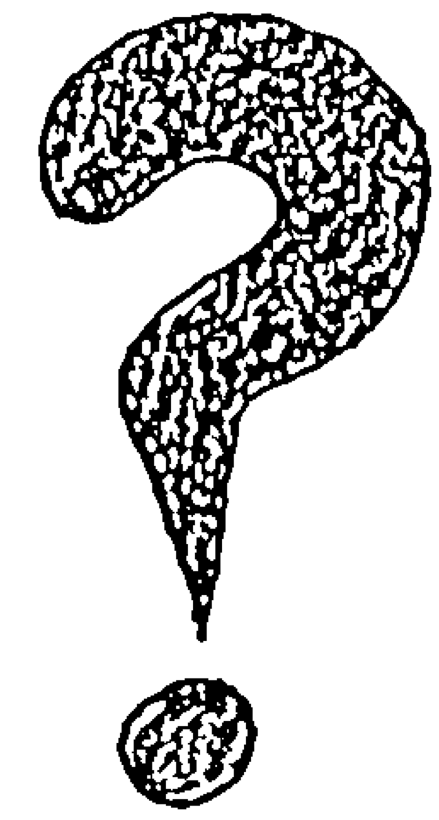
Maths needs to be fun and enjoyable, then more students will take an interest.

Adults: it's a second chance for some who have had a bad experience at school and have little or know formal education qualifications.

What most students said was you need maths for everyday living to understand bank and building society statements, bus and train timetables, paying electric and gas bills, paying the rent, council tax, buy the food for the week, how to measure yourself when you buy

cm

clothes, to tell the time.



Notes from a discussion group Antoinette

There are lots of ways of working out maths.
People could not do it at school.
Mock exams good.
Fractions, %.
Like idea of a group.
Homework important at home.
Pressure if someone did not succeed.
Maths now interesting.
Doing everyday maths.
Teacher must be good.

To the Organisers of the Maths Conference

We would like to say thank you, for inviting us to the session. It was well organised and the food was very good.

Everyone was so friendly and we felt welcomed and comfortable.

We hope to come back again.

From Sheila, Mario, Donna, Vida,. Aston
CAVE

The conversation was very interesting and intellectual. The opinions of others were very amazing and incredible. It was useful for both students and tutors to hear the valued ideas and opinions of other students from across the country.

D Bailey
V. A. Amankwaa
A. Turner
M. Richards,

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Jeremy

My name is Jeremy. I am a student at Southwark College and Bede Education Centre. I need maths for my course I am doing in accounting, so I am able to work the formulas out.

This is now why I want to become an accountant, because I enjoy maths and working the formulas out. It is just like a puzzle. I also want to do some maths exams and get some qualifications.

This is a sample spreadsheet. The company gives a 4% discount for all customers who order more than £5000 of goods.

Goods booked plc

Orders analysed

23.1.97	**Orders**	**Discounts**	**Sales values**
	£	**£**	**£**
Scheiermancher	4900		4900
Strauss	6000	240	5760
Schweizer	7000	280	6720
Total	17900	520	17380

C6 =B6*4%

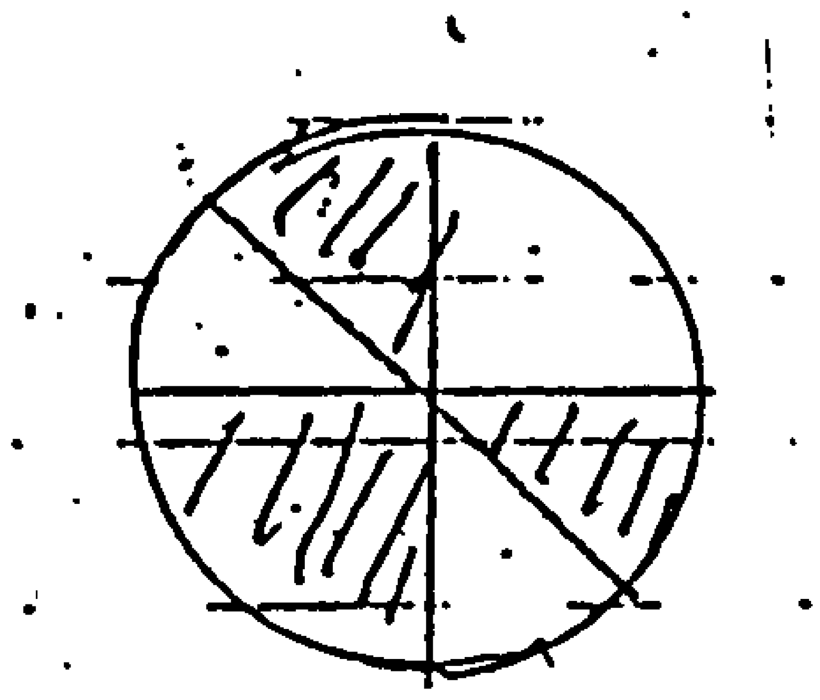
	A	B	C	D
1	**Goods booked plc**			
2	**Orders analysed**			
3	23.1.97	**Orders**	**Discounts**	**Sales values**
4		**£**	**£**	**£**
5	Scheiermancher	4900		4900
6	Strauss	6000	=B6*4%	5760
7	Schweizer	7000	280	6720
8	Total	17900	520	17380
9				

D6 =B6-C6

	A	B	C	D
1	**Goods booked plc**			
2	**Orders analysed**			
3	23.1.97	**Orders**	**Discounts**	**Sales values**
4		**£**	**£**	**£**
5	Scheiermancher	4900		4900
6	Strauss	6000	240	=B6-C6
7	Schweizer	7000	280	6720
8	Total	17900	520	17380

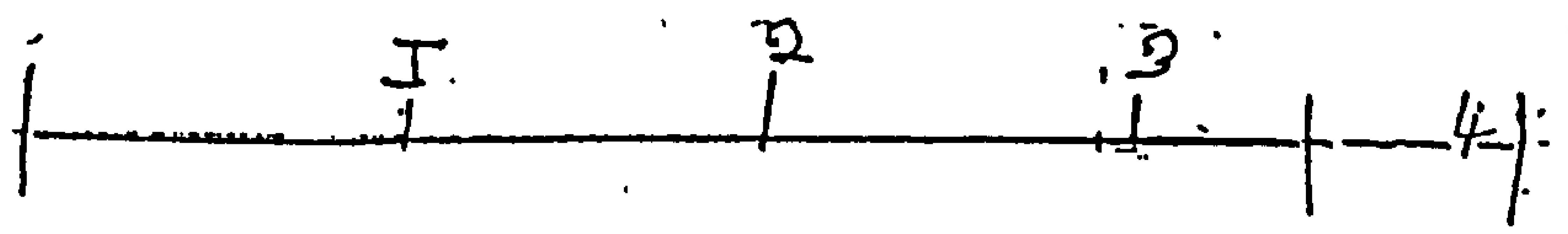
Parts of a Circle

1) In the diagram, 3/6 of the circle is shaded, It is cut into 6 pieces, the 6 in 3/6 is the number of pieces (Denominator) and the 3 in 3/6 is the number of pieces shaded (The Numerator).



Can you think of one?

2) This line is more than one inch, but less than four inches long, What is the Fraction?

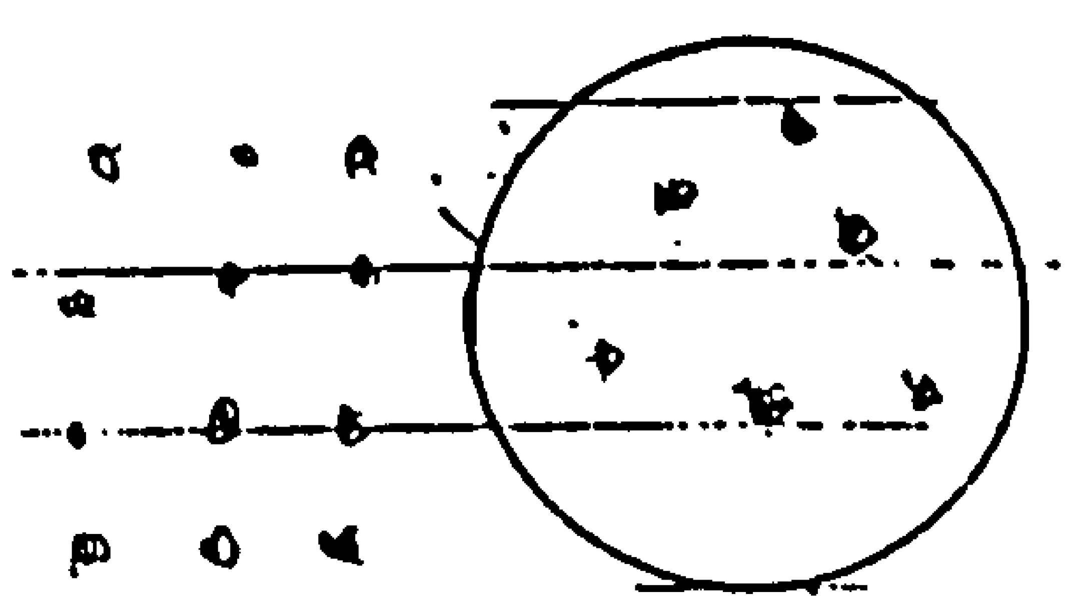


3) Suppose you was to share 5 cakes equally between two people, Here are two ways of writing it down.

$2\overline{)5}$ $\frac{5}{2}$

Each person would get this much:

4) Name the fraction which represents the circled part of the diagram.



5) Out of 489 Scotland Football team(in 1990) only 6 were form the north,. What fraction of the team are from the north.

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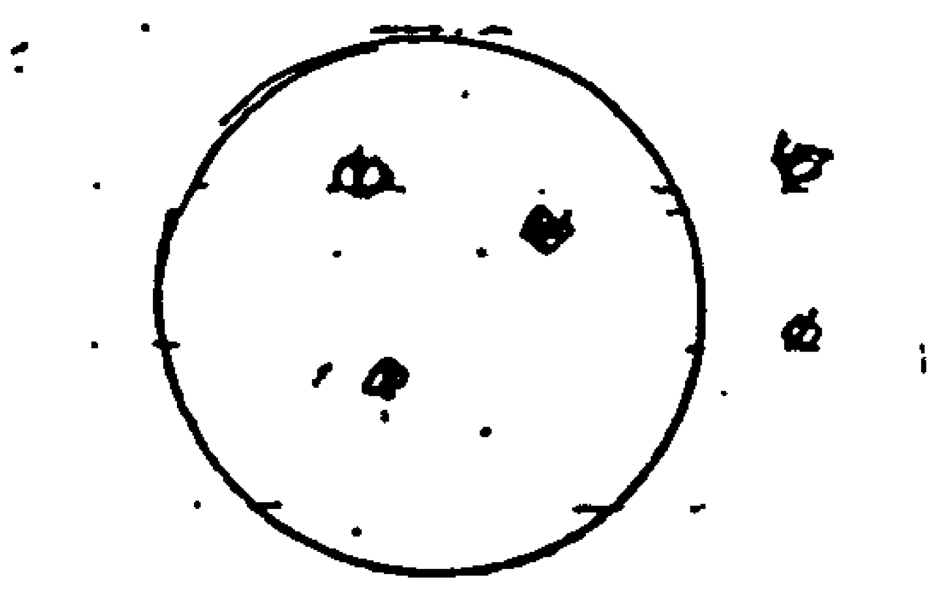
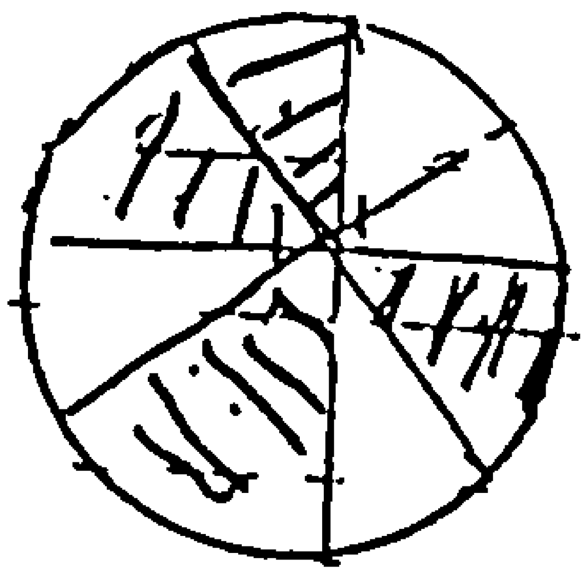
6) **According to the Southwark County, one in six employers discriminates against bláck job applicants, Write that as a fraction.**

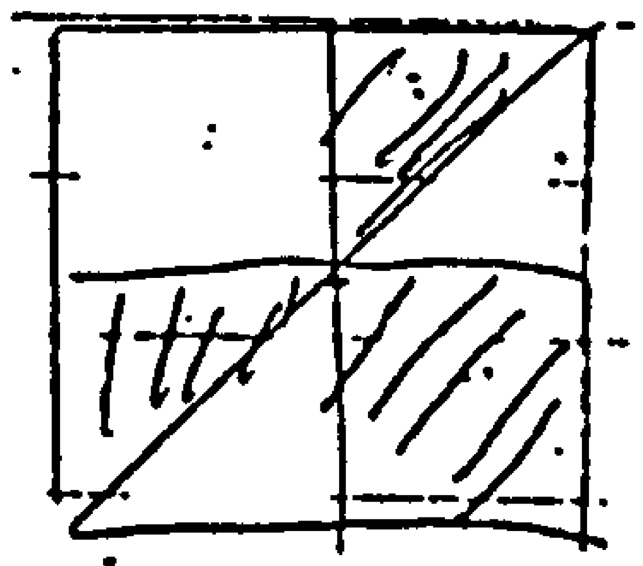
7) **Suppose 2 people are sharing a lottery win of £ 248,10 between them, how much will each get?**

8) **How many people are in the room? How many of the are English or other, write it down in fraction of people.**

9) **Name the circled of shaded part of each diagram:**

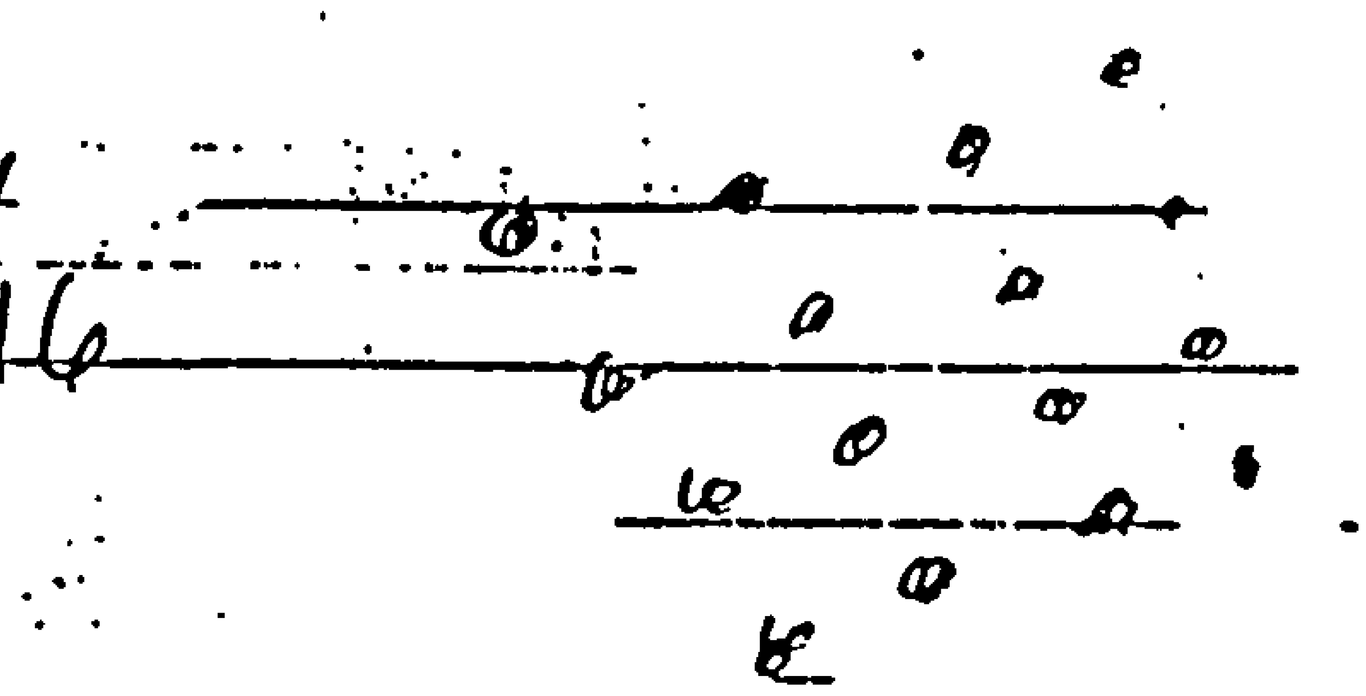






10) **Shade in or circle the given fraction in the diagram.**

8/16



Sandra

1) PUT THESE NUMBERS IN ORDER OF SIZE WITH THE SMALLEST FIRST

(A) 305 (B) 35 (C) 350 (D) 530 (E) 503 (F) 53

2) PUT THESE NUMBERS IN ORDER OF SIZE WITH THE LARGEST FIRST

(A) 51 (B) 15 (C) 510 (D) 150 (E) 105 (F) 501

3) MAKE A ROUGH CHECK TO SEE IF THIS SUMS IS CORRECT are they right or wrong?

(A)	(B)	(C)	(D)	(E)
5099	689	5002	4001	35
3999	372	3001	2002	15
1001+	110+	1001+	2999+	45+
9099	1171	94	90002	95

4) DO THESE FRACTIONS AND FILL IN THE MISSING NUMBERS

(A) $\frac{1}{4} = \frac{}{20}$ (B) $\frac{2}{3} = \frac{}{6}$ (C) $\frac{5}{6} = \frac{}{12}$ (D) $\frac{6}{7} = \frac{}{42}$ (E) $\frac{1}{2} = \frac{}{10}$

5) REDUCE THE FRACTIONS TO THEIR LOWEST TERMS

$\frac{3}{9} =$ $\frac{5}{15} =$ $\frac{15}{25} =$ $\frac{5}{20} =$ $\frac{15}{30} =$ $\frac{16}{20} =$ $\frac{6}{12} =$

6) I have $\frac{2}{3}$ bag of ready-mix cement left and I am given $\frac{1}{2}$ bag by my neighbour. How much do I have altogether.

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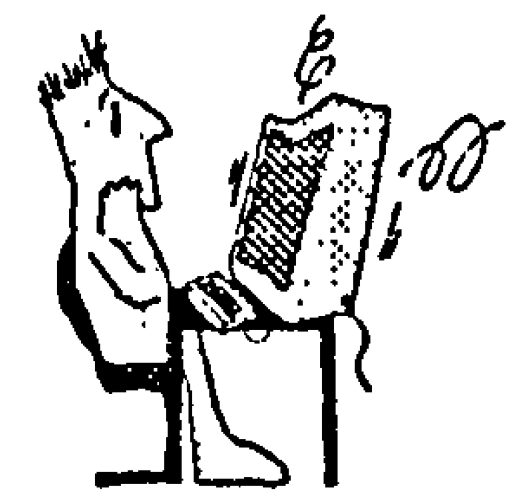
Writing maths questions

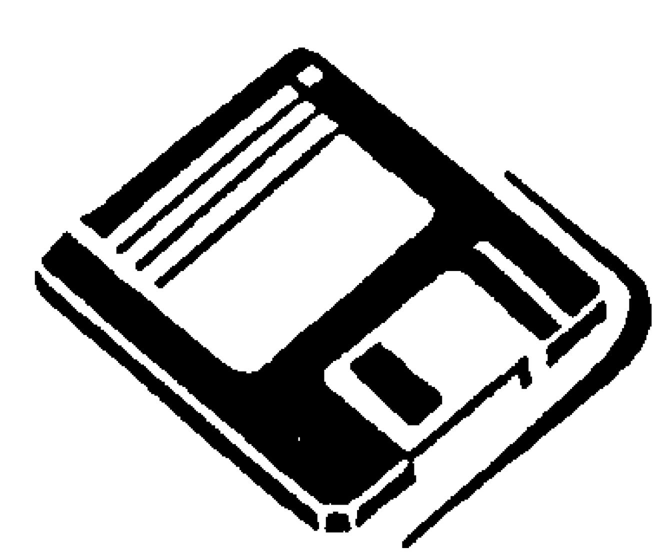
Sandra worked on a pack about fractions.
In the pack, students are asked to write a five-question quiz
to review what they have learned so far.
Sandra wrote ten questions, not five.
This is what she said:

> I didn't think of thinking them up myself,
> at first kick off.
> So I says
> 'Right, I'll look at the first question in the pack,
> and then make one up from there,
> copying the same thing.'
> So I tried, and I tried, and I tried.
> All I could get out of that was frustration.
> I was giving myself a headache.
> I thought,
> 'There's got to be an easier way than this.'
> The rubber was getting good use.
> I did the ten questions,
> but they were not easy.



Then Sandra worked on the second half of the fractions pack.
Again it asked her to write a five question quiz
to review what she has learned so far.
Sandra wrote five questions
but this time she didn't copy the style of the questions in the pack.
This is what she said about it:

> I sat down, and I says,
> 'Right, I'm not going to fall into the same trap.
> I'll make up five other questions.'
> If I read the worksheet problems,
> I get frustrated, I sweat, I panic.
> So I decided to just sit there,
> and write down the questions,
> calm, calm.
> But the easy bit didn't come easy!
> After a while, my husband says,
> 'Sandra, are you getting stuck?
> Go and look in your book!'
> But I says, 'No, I'm not opening that book,
> it spoils my concentration.'
> So eventually I wrote the first one,
> and once I got the first one out,
> there was no stopping me.



Sandra wrote some questions that were not about fractions,
even though she was studying fractions at the time.
She said,

I knew the block was there,
but I keep pushing myself.
The questions were hard to think up
and write down.

She had written questions that she knew would be difficult for her.
She put them at the beginning of her list of questions:

Get them over and done with.
I thought it would catch some people out,
including myself,
which it did.

What makes writing maths questions so difficult?
Sandra is dyslexic,
so for her the spelling is a problem:

The reason why I tried copying from the booklet
is so my spelling wouldn't be caught out,
and to keep in mind what rhythm of the questions.
I had the dictionary, too.
The two worries, spelling and maths, stand together.
So I don't worry about the spelling,
I just carry on,
and stay relaxed.

But when I stopped and put everything away,
and then looked at them,
I said,
'Sandra, you are pretty clever'.
So I do enjoy it.
I felt really good
because it was designed for me.
When the class have finished with my questions
and answered them,
including myself,
I said, 'Sandra, good!
After all your hard work, good!'
Most of my childhood,
or the bit I did have at school,
wasn't very nice.
So I missed a lot out.
Now, I'm only catching up.

Sandra Wilson talked to Alison Tomlin, January 1997, at Bede Education Centre

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Mathematical Ingenuity Andrew Davidson

At Elementary School, I remember learning multiplication tables repeated at regular intervals by the teacher. At Secondary School, I enjoyed doing problems in Arithmetic, Algebra and Trigonometry, but not so much in Geometry which I found difficult. My elder brother was very helpful in solving problems. I was disappointed not to get into Higher Maths at school.

Later I was impressed by the calculations of Astronomy dealing with cosmic distances, light years etc.

Finally I was intrigued by the mathematical ingenuity of the binary system, which made the information technology of the computer possible. There was something truly marvellous about using a two digit system (0/1) to transmit information on an electrical current (off/on). Decimal numbers were changed to binary numbers and vice versa. By means of a code, words were also reduced to numbers and then brought back to their original form in the Word Processor.

All this became clear to me after taking an Adult Education class in Maths.

Maths History Edna Donovan

I started learning maths in the 1930's whilst attending infant school in the West Indies, and continued up until the age of 15 where I reached a level 3 which would probably be the equivalent to the English CSE.

I enjoyed learning maths but remember finding it quite difficult especially areas such as Algebra. Whenever I got stuck the teacher was always very helpful. If I get stuck in this class I would like the teacher to re-explain things to me.

My happiest memory of maths is when I passed a maths test in 1954 which led to me being accepted to study for a career.

As the years go by I have been relying on conversion table and calculator, and have not used the mathematical skills which I learnt in school. As a result of this I have forgotten how to do maths on paper.

Maths is essential in our daily life. Improving my maths will enable me to have more confidence in myself.

My Maths History **Joyce Gray**

My maths history started a long time ago. I started Nursery School (which in my time and country was called Private School, that is now called Basic School) at the age of about 4. At the age of 7 I entered Primary school.

I do not have much memory of the early years, but from about the age of 9 upwards, Maths gets harder and harder. I did not love or hate Maths, but found it difficult at certain times to do, because in my school days in the West Indies, if you could not do the work after being shown a few times, you were in for a taste of the teacher's belt. Things were so different then. You get very scared the moment it's time for Maths. At times you know the answer for a particular solution, but are scared to give the answer just in case you are wrong. It was not always bad. One thing for sure, you had to know your times table, and mental arithmetic was another thing you had to be quick at. At one stage I was very advanced in doing simple proportion and a few more, but eventually lost track of them.

So about 26 years ago, I went back to evening classes for about a term, to get the hang of long division, LCM and HCF, which I'd picked up but I have since lost them, and I never seem to find the need for using them, especially LCM and HCF.

One of my most memorable embarrassing moments in the whole of my maths life, was when I was about 10 years old, sitting in Church not listening to the vicar's sermon, when he suddenly asked 'How many sixpence in 2 shillings and sixpence?' (2/6) Knowing the answer was 5, I told him 4. That shame is still with me until this day.

At school there were times we were allowed to work in groups to do our maths. There was one pupil who if he did not know how to solve a problem, he would willingly work with us, but if it happened the other way, heavens help us, because he would not help us. We all hated him for that.

My Maths History

Yvonne

I cannot remember who I learned numbers from, but I suppose it was from my mum.

I didn't like school very much and I took a lot of time off. I went for one week and had two weeks off, most of the time. My maths teacher was about the only teacher I liked at school. Maybe that is why I enjoy maths. My English teacher told me it was a waste of time and money for them to put me in for my exams, because I took so much time off school. So I thought why bother! My science teacher told me I needed to do more P.E. to get some of that fat off. I informed her she was my science teacher not my P.E. teacher and she should mind her own

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business. Every teacher I had made some rude comment to me, but my maths teacher was O.K.

His name was Mr Matthews. He did make a comment one day. He called the names out, and when it got to me and I answered he asked me, "What is wrong with you today that you've come to school?" I told him. I was sarcastic, and then he said he was sorry for upsetting me. I think everyone gave up on me at school so I gave up. I now want to do my GCSEs to prove to myself I am not hopeless, which is what my teachers made me feel.

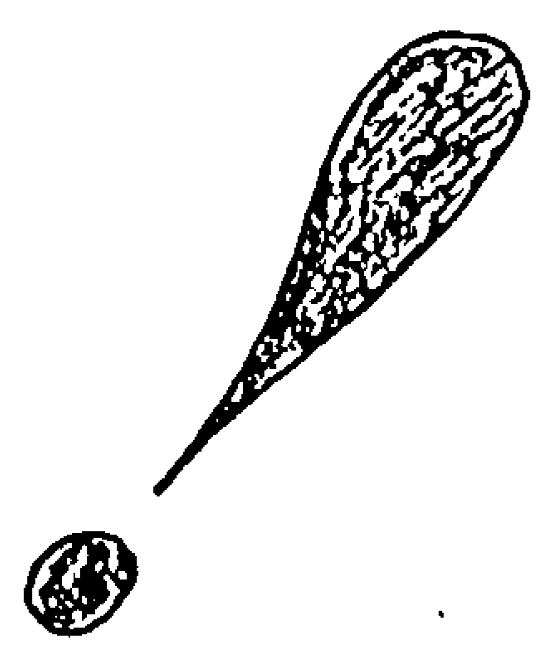
It didn't make a lot of difference if I got stuck with my work at school, because I just took time off and by the time I went back they had gone on to something else.

When I was off school a lot the (what we called) school board people came round to find out why I was not at school. This woman told me I could tell her anything and it would go no further than me and her. She asked me if I liked my head of house, and I told her I didn't. I agreed to go back to school, and I had to see my head of house. I walked in her office and the first thing she said was, "I hear you don't like me very much?" This woman gave me great confidence in all people to do with education. I now knew I couldn't trust any of them! I think if they had tried finding out why I didn't go to school instead of putting me down when I did go, I might have gone to school.

Dear Maths teacher,

I am writing to say thank you. I joined this course after plucking up the courage (that took me years), thinking I may just pass this course. You have made me feel I can try to do my G.C.S.E. in maths, and I'm not wasting everyone's time. I feel in the short time that I have been on this course I have gained a lot of confidence. I am enjoying the course.

All my school reports said "Yvonne is not at school often enough for me to make a comment."



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Mathematics History

As a child my life in school was hell, because I had a problem with numbers, like putting them in the right order, or sums with 0 - I can't do then or now.

Problems, I would come out in a cold sweat because I would forget the reading half of the time.

The teachers all the time would call me lazy, stupid. They would give me six of the best, or write lines, but most of all put me in a corner of the class and sometimes make me wear a hat with a D on it. Everyone said, 'There goes the dunce, she knows nothing.' It was either that, or put to the back of the class.

So I would ask for help, but the teachers had no time for me.

It would go on in my adulthood life, until I was tested five times, and told, 'Sandra, you are dyslexic.'

I thought it was a disease until I was told the reason I could not do my mathematics was, I would learn at a slower pace, but I am learning. I also noticed I have spelling difficulties, but I have taught myself some, and the rest from the tutors in Bede House.

I get terrible frustrated at times because my brain can think one thing and I write down another, but I still panic a lot even now. I wish I had a magic wand to make my feelings go away, and also cure my dyslexia.

Sandra

Lorraine Davies

You and Maths

Have you any happy, unhappy, angry memories connected with maths?
My happiest time was when we had a school assembly where achievements were being given for good exam results. I was surprised when they called me, for coming second in the whole year for my GCSE maths.

I was unhappy and angry when I couldn't solve a sum or couldn't understand it.

Maths makes me feel ...
pleased when I can solve a problem, and determined to find a way to solve it.

Maths is ...
working with numbers, measurements.

When I get stuck I ...
try to work it out by myself trying not to get into a state. If I fail I will ask the teacher.

I panic when ...
I can't get to answer a question or sum, or if I have already done a sum, but can't remember how to do it.

Have you any particular aims in coming to this group?
I would like to improve my maths, i.e. fractions, division, also shapes and maths they use in the national curriculum so I can understand what my children are learning.

Tell us about your maths history
My mum and dad taught me my first numbers. I also have five elder brothers, who used to count with me and help me to add up.

I have worked with maths at home, at school, at work and at Bede House. At home, I have worked with maths through counting, i.e. steps, money, people in the room, toys, bricks. At school I used counters, beads, bricks, sticks, calculators. At Secondary School I learnt to count in French up to 50. I can remember most of it.

At work, I worked first of all in a chemist where I used to serve customers, which meant adding up prices of items which they had purchased, receiving money and giving change, and also stacking shelves, I had to count how many of different items were needed to fill up the shelves. I worked in two chemists, the work was the same.

My second job was in a dry cleaners. Each load was counted and weighed. We had to measure the amount of fluid put in the machine, and also time it. When it came out of the machine it had to be sorted, pressed and labelled, and put into sections in number order.

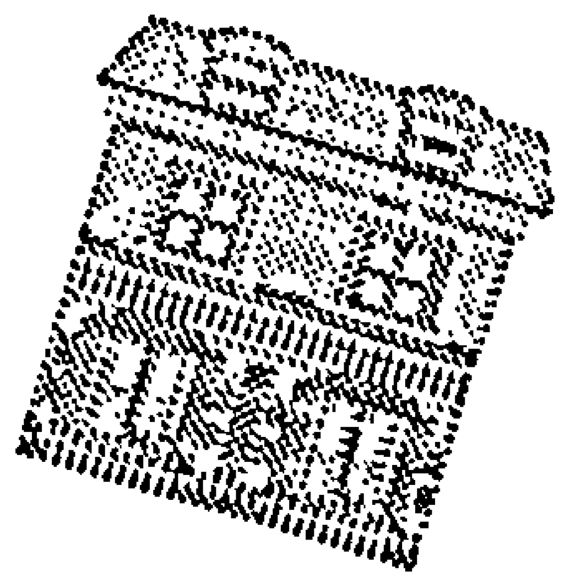
My next job was cleaning. I had 18 offices to clean in 3 hours, so I had to divide the time between each office. The offices each had keys with numbers on them, and were on three different floors.

I worked in Peak Freans biscuit factory. You had to gather a row of biscuits together and put them in rows in a tray. When the trays were full you had to stack them 10 high. If they were packed into wrappers the machine would allow only a certain amount through each time.

I worked in a doctor's surgery where I had to book appointments, collect files, count the patients each day and use and answer the telephone.

House Insurance

L. Dingwall



Leroy disputed the cost of his house insurance
when he found he was paying more than his neighbours.
He found the premiums are based on the rebuilding costs.
He had to measure the rooms,
but then he found he could measure round the outside,
rather than do each room separately.
These are the figures Leroy worked out.

Three bed semi

Type of property	Semi-detached
Area	
Ground floor	26 ft x 21 ft = 546 sq. ft.
First floor	546 sq. ft.
	546 + 546 = 1092 sq. ft.
Average rebuilding cost per sq. ft.	£54 x 1092 = £58 968.
Shed, patio, fences	Extra £1032.
Total rebuilding cost	£60 000
Total sum to be insured	£60 000.

255.

My Maths History

Tracy Morris

I remember when I first started maths in secondary school. Well I was behind anyway. I just was not taking it in. We all worked on our own. I remember my best friend Hannah standing up to read out the answers to a list of 10 homework questions we were given. She only had a couple wrong yet she was called thick by some girls in the back row. Well that put me off, she was so upset. They should have seen mine. Since then I've dodged maths completely. I don't now, but I've managed to get on without it. You just do. But now I don't want to manage. I want to be able to help my nephews, nieces, brothers and sisters with their homework.

Maths makes me feel ... Before, very scared. I would try to avoid it. But now I'm confident enough to have a go at it.

Maths is ... Different. Useful, and can be fun (sometimes).

When I get stuck I ... stop! take a break and then start slowly reading over what I've done, before I go back to the question I was stuck on.

I panic when I'm left behind. I'm on question 4, everybody else is on 6. That's when I really panic.

Almost half my life being wasted by Demetra

From Cyprus to England

My mother said to me when I was three years old I had to point at the tap, when I wanted a drink of water, or anything else. At the age of three I then began to understand and to speak very little Greek. My parents decided to come over to England when I was four. I can remember staying at home and playing with my dolls, prams and things like that. I did not do a lot of talking because I was not taught to try, instead I was pushed in the corner and not taught by my own family.

Primary School

I remember my primary school. I can't even remember me doing a lot of talking at school, but just saying yes or no. I had to have speech therapy as I was suffering with stammering. I even got in trouble for trying to explain to the teacher that a girl pinched my rubber. The teacher punished me for talking, and put me to stand in the green metal bin. Then came play time. I was teased by the children in my classroom. It was awful because I couldn't say anything to anybody, but I went to the teacher and hung around her.

I then struggled to move to two or three classes, and then my head teacher invited my parents to talk about me moving on to a special school. I was not involved in the conversation. My parents agreed that I should go to a special school. When they told me that I should go, all I can remember is I broke down, and begged them, "Please don't do this to me, I don't want to go to a special school. They're not good. I won't learn anything there."

But my parents did not know English themselves, so they could not help me much. They did not realise that because of moving from Cyprus to England, it will affect me much in my education. They did not know their rights. In the 60s, people did not recognise how it can affect children's mind by moving from one country to another, as it has with me. People thought back in the 60s that you were backward. They did not understand how to cope with people (children) learning English. They thought it was confusing for them. But how about me?

I then started Lansdowne School in Stockwell, about seven years old. I can remember doing a lot of playing and not much reading, writing and maths. That's all I can remember at that school.

Secondary School

I then moved on to Shillington Secondary School in Falcon Road, Clapham Junction. I can remember me begging my parents not to send me to that school. But you think they would listen to a child? No they did not. I also told them that it is a very bad school, they don't have exams or anything like that. There were even girls getting pregnant at that school, and children getting raped and beaten up. They thought I was making all this up, as parents do think, but no, I was not making anything up!

My parents always asked me where is my homework. "Don't you have any homework? Well what do you do all day at school?" Honestly I don't know myself. All I can remember is that we went for a half day of games, i.e. swimming, rounders, badminton and judo, and the rest of the day I can remember doing a bit of Human Biology, English, Maths, History and Special Studies, i.e. economics and politics. All these were just very simple basic classes. I also used to go to the head teacher to ask her for more homework. Because my father went up to my school to inquire about homework, therefore the head teacher had to give me more work every night. The last year at school, I wanted to stay on to become a nurse and do day release at college too, but I was taken out of school at the age of sixteen.

Work

I was sent to work with my father in the greengrocer's. My parents saw me unhappy again. They decided to send me to go with my mother into the dress factory. I was there for five years. I saved enough money and left at the age of 23, and did a seven months private course. I finished at 24 and became a hair-dresser for twelve years. I stopped work because I couldn't take it any more about five years ago.

UB40

Not being educated I really struggle for interviews. When they gave me forms to fill in, and CVs, I just could not fill half of the forms and everything else. I went in and out and around London and just had to give up at the end. I was on UB40 and I had a hard time with them as well.

Education

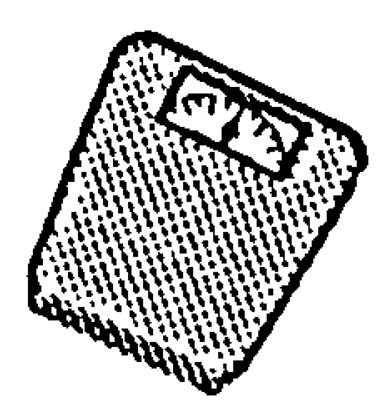
Then I realised that I had to educate myself. So I booked myself a lot of courses, i.e. Maths, Spelling, Computers and English. I started four years ago with maths. I was there for two years before I had any confidence to do my Level One in maths. In 1995 I passed and got 87 per cent. Then one year later in 1996 I did Level Two and I got 60 per cent. In 1997 I failed and got 40 per cent due to a next door neighbour who insulted my intelligence and my self esteem went down. But all that is in the past.

Now, I have to try and work harder than last year to make up for lost time. I'm still going to college. I am getting there, praying that next year I will be able to get on with my GCSE. So I really feel now that at least I am almost there for more and higher education. I felt almost half of my life being wasted for nothing, because of one unnoticeable mistake, that when I came to England they did not bother to teach me.

Maths

I often get quite embarrassed when I go to Weight Watchers, as I collect their money on a Monday night. There is a very long queue. Even when I'm serving a customer, the queue is expanding even more. Everyone can see me using my fingers and I hear them saying horrible things about me using my fingers. Most of the time I just feel pressure coming up and want to get up and run for the door. The figures I usually use are £3.95 + £1.85 + £1.50, small little figures like that and it just slows me down. I don't want that any more. I just want to calculate quicker than just using my fingers and so on. I need plenty more knowledge in me. I want to get on by without any difficulties or embarrassment. I also want to control financial affairs, i.e. mortgage, loans, tax, VAT and even starting my own business one day.

I don't want to be taken for a ride any more as from now!



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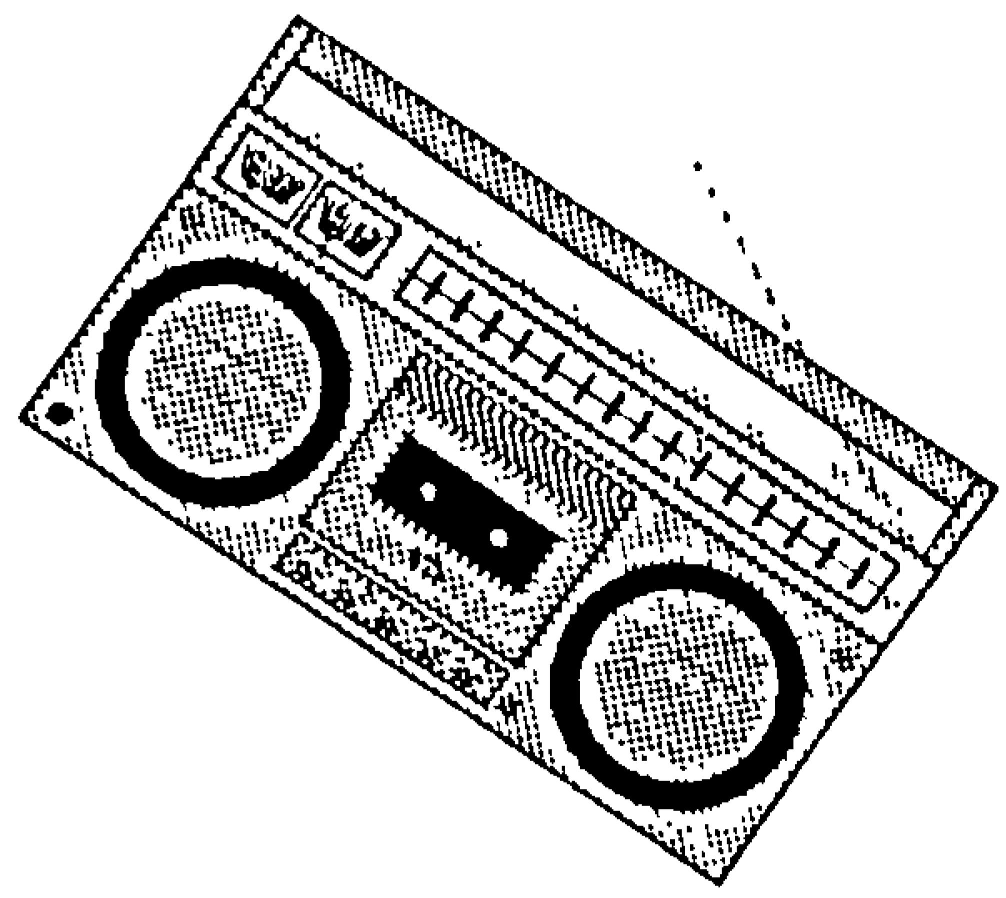
Problems written by students

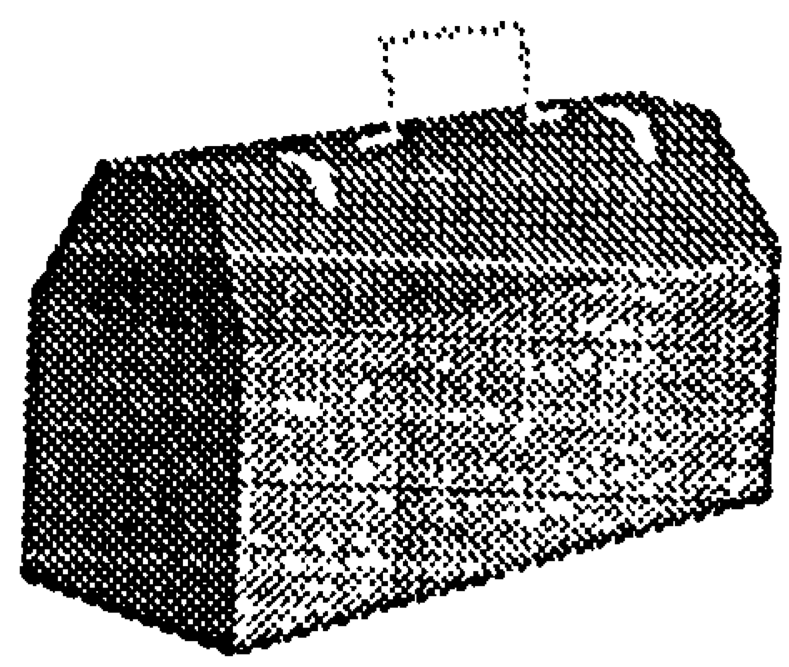


Jim
A world-wide transistor radio cost £38 in a sale.
It was £50 before the sale.
How much did I save?

Owen
Find out the cost for painting a room, 8 foot by 12 foot.

The ceiling, skirting board and windows	Two gallons of paint
The walls	Two gallons of paint

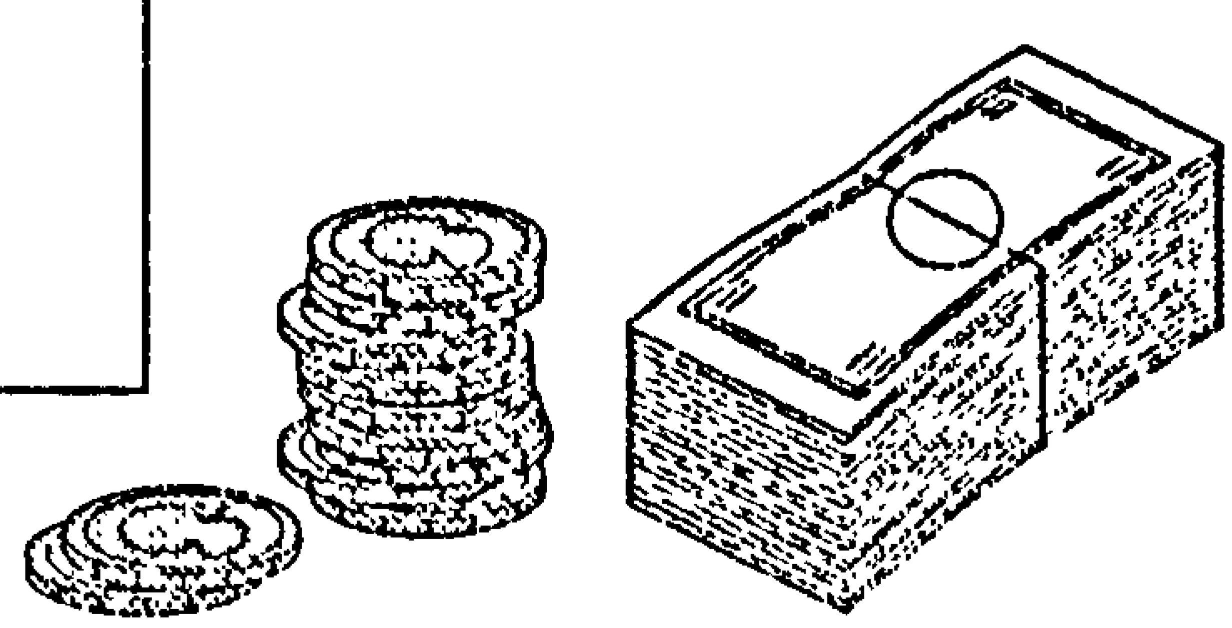
One gallon of wall paint would cost about £15.
One gallon of ceiling paint would cost about £20.
Two brushes - about £3.50p for the pair.
A rolling brush - about £2.50p.
A paint tray £1.50.
White spirit, ½ litre £1.50.



Leroy
1. Tiling a bathroom.
The bathroom is 8 foot by 10 foot.
The tiles are 4" by 4".
35p each.

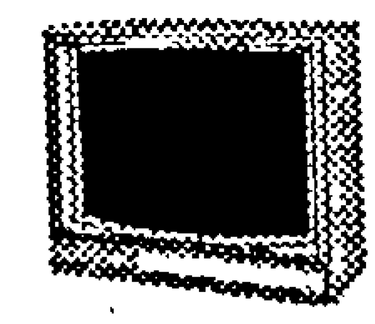
2. Rent £76 per week.
Find the total for twelve months.

3. Mortgage £114 per month.
What is the yearly total?



Tanya

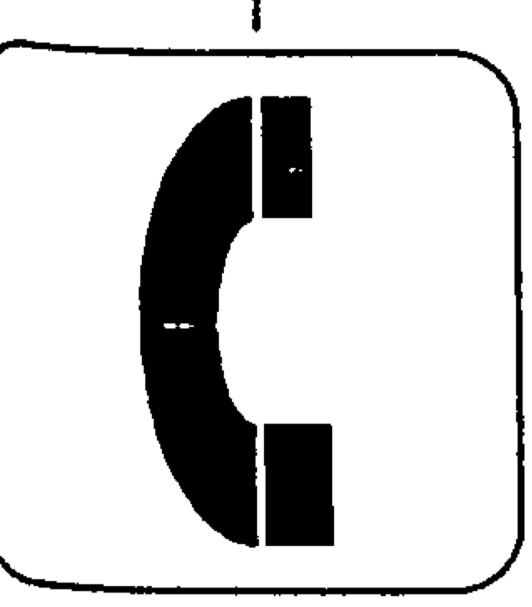
1. If you bought a pair of jeans for £32.50 and gave the salesperson £50.00. The salesperson asks you for £2.50 more, how much change would you get?



2. If you buy a T.V. on credit for £47.75 a month over one year, how much does the T.V. cost?

3. If you buy three bags of apples for £2.50 and there are 10 apples in each bag. How much does one bag cost, also how much does one apple cost?

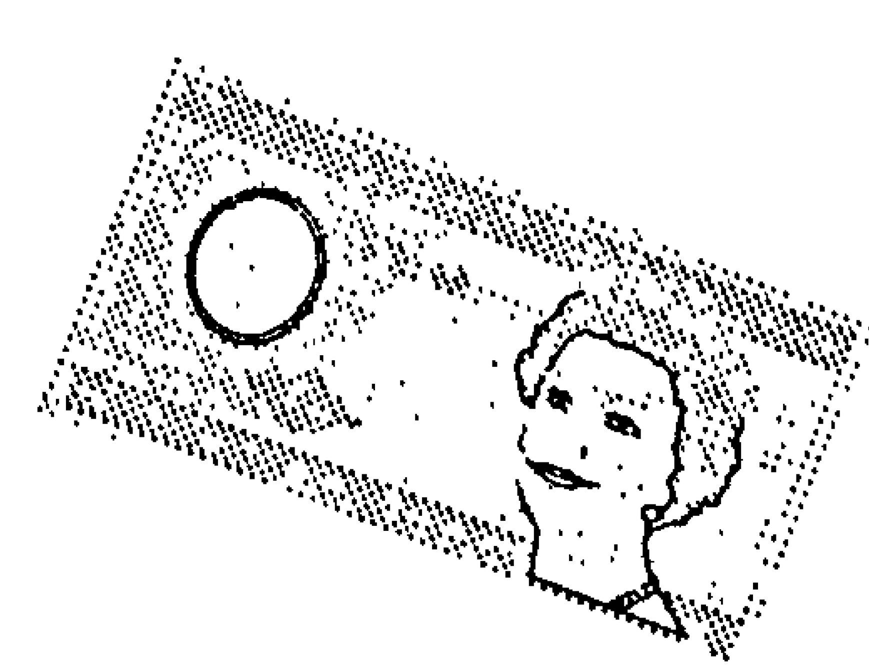
4. There are 12 people waiting to use the phone. Each person spends 28p a minute and 3 minutes and 45 seconds on each call.



a) how much does each call cost?
b) how much do all the calls cost?
c) how long does caller number 9 have to wait before it's his turn to use the phone?
d) how long does caller number 11 have to wait?

5. 6 children have to share 8 slices of birthday cake. How much exactly does each child receive?

6. You go to the supermarket for soap powder. You have with you two tokens for 35p off. The powder costs £2.69, but you see that if you buy two you get the third for ½ price. How much will three boxes of soap powder cost?



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Students talk about maths

1. Writing a maths diary

Two students, Paulette and Cindy, have been keeping a maths diary.
They talked to each other about it,
and compared their diaries.
They go to the same class
and they often work together,
but their diaries are very different.

Cindy	Paulette seems to write just exactly what we *did* in class. She doesn't discuss her feelings much. But I do, I'm always saying whether I felt pleased or bad or whatever.

Why write a maths diary?

Paulette	Writing the diaries, you can reflect back on what you're doing right or wrong. It's like a memory thing. It's written down, and it's something you can refer back to later on.
Cindy	When the teacher first asked us to start a diary, my heart sank, and I thought, what a waste of time. But I can see the point in it now. Over the weeks you begin to get a picture of what you have covered, and it does jog your memory a bit.

Paulette reads her own diary, but Cindy doesn't.

Cindy	To be honest, I probably wouldn't have read it.
Paulette	I always read my diary. It's like I'm keeping a day-to-day note of what you're doing. Sometimes we do make mistakes, and you know I think we should go over our own diaries.

2. Advice for tutors

Cindy

I have enjoyed the course,
but sometimes I think it is a bit wishy-washy.
You get told that you have done very well
because you're *almost* right,
or on the right tracks.
But in maths I think you're either right
or you're wrong.
I wish you were told you had got it right,
or you had not got it right.
It's kidding yourself.

Paulette

But you are gaining more than you thought you would.
I think the confidence I do have
is because of the teacher.
Being adults,
and having children of our own,
and feeling inadequate when our kids come home
and we're not able to help them -
having the right teacher
and being in the right atmosphere and company,
it does help.

Cindy

Yes,
and maybe that's why the teacher never says,
'You've got that all wrong'.
What would be the point?
You probably wouldn't come back.
And it's only Basic Maths,
perhaps at this stage it's not all that important.

Paulette

You feel like you're in the winning *team*.
Like me, I'm generally a quiet person,
but because of the confidence that I feel,
from the teacher and the other pupils,
I feel it's refreshing my memory.

3. Advice for students

Cindy and Paulette went on to talk about their maths class.
This is some of what they said.

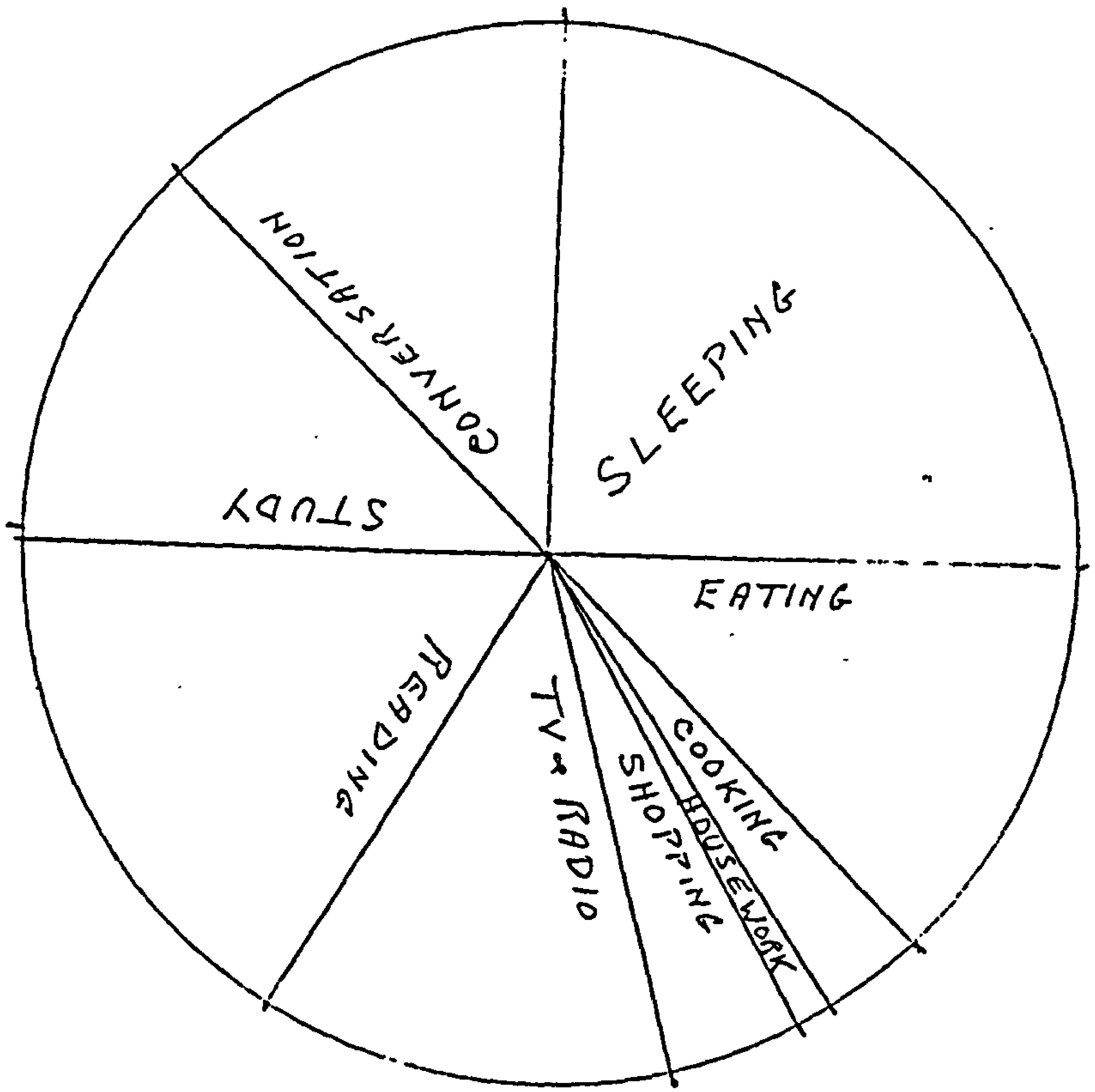
Paulette

I think it's important to *keep coming*
and not just come once every month or whatever.
You miss out so much.
You must take it seriously
and try to keep up with your studies,
so you know you are always ahead,
instead of feeling left behind.
You gain confidence when you go to college.
You are meeting people,
exchanging thoughts and ideas.

Cindy

I do like it when more of us turn up to the lesson,
because you think,
'We're all in this together',
and it is quite good fun.
I mean I don't look forward to it particularly,
but once I'm there I enjoy it.

MY DAY



SLEEPING — 6 HRS
EATING — 3 HRS
COOKING — 45 MINS
HOUSEWORK — 15 MINS
SHOPPING — 1 HR
TV & RADIO — 3 HRS
READING — 4 HRS
STUDY — 3 HRS
CONVERSATION — 3 HRS

Andrew Davidson

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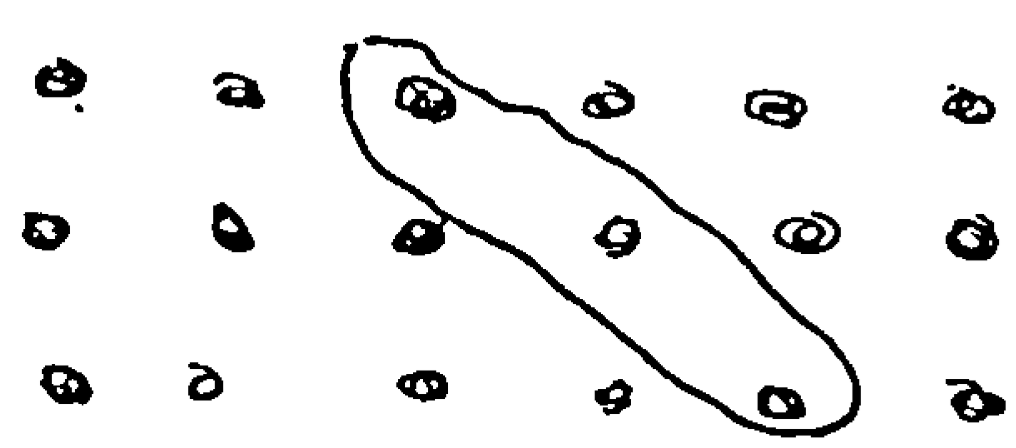
Fractions questions

Lorraine

a) I have 4 children, two boys and two girls.
What fraction of boys are there out of 4 children?

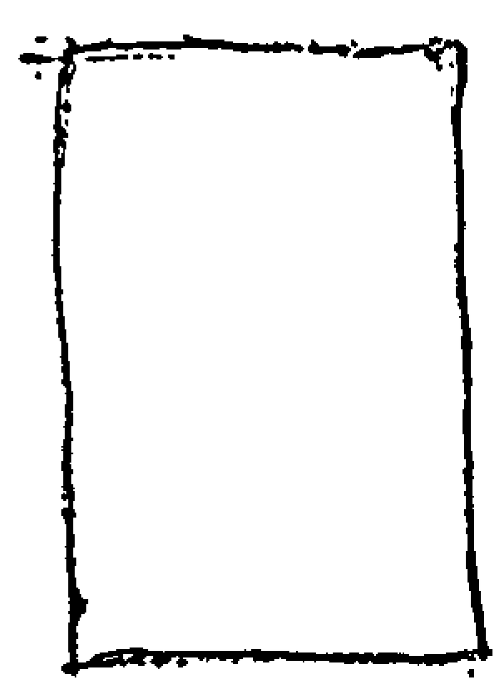
b) I bought 8 apples. 4 children wanted 1 apple each.
What fraction would be left?

c) Only 3 children wanted a piece of cake that had been cut into 4.
What is the remainder of the cake?

d) 

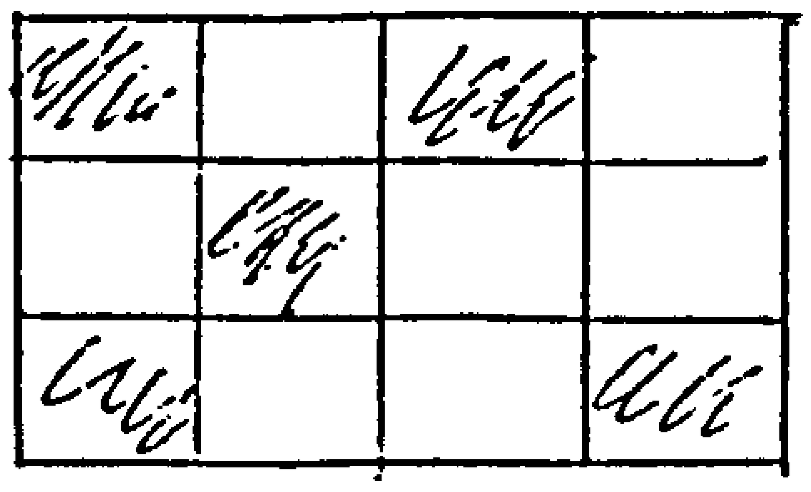
Name the fraction which represents the circled part of the diagram.

e) Shade in ¾ of the oblong below.



Tanya

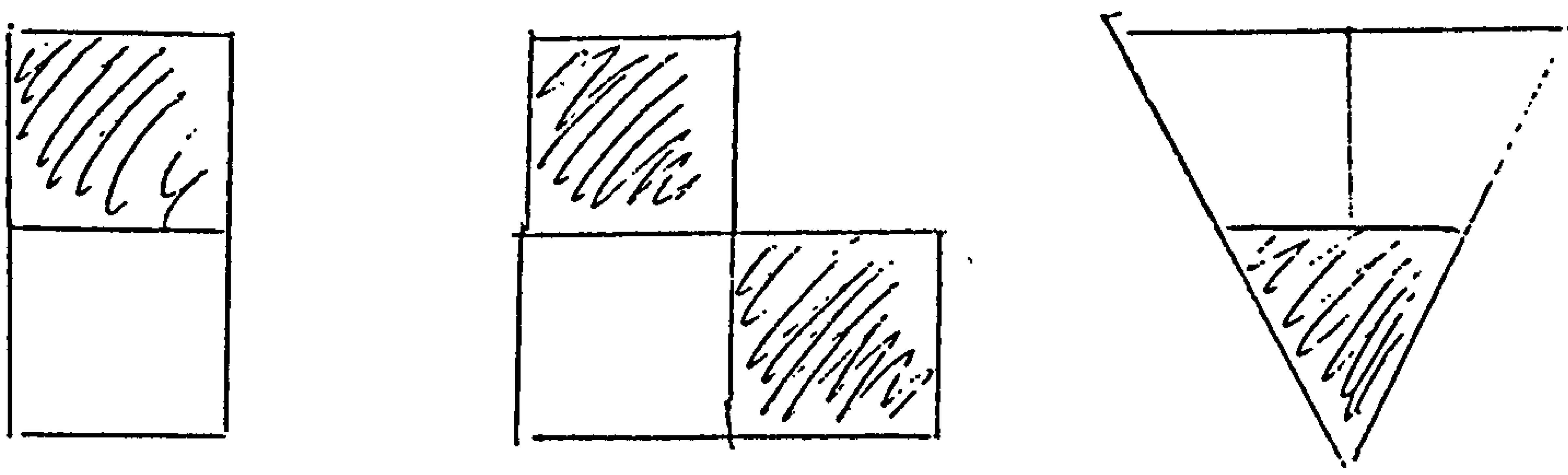
Q1.



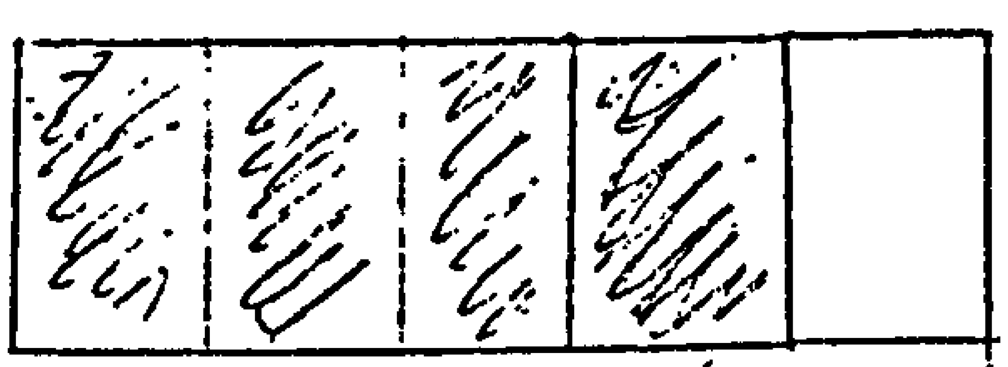
$\frac{5}{7}$

Say where and how I went wrong.

Q2 Name each fraction.

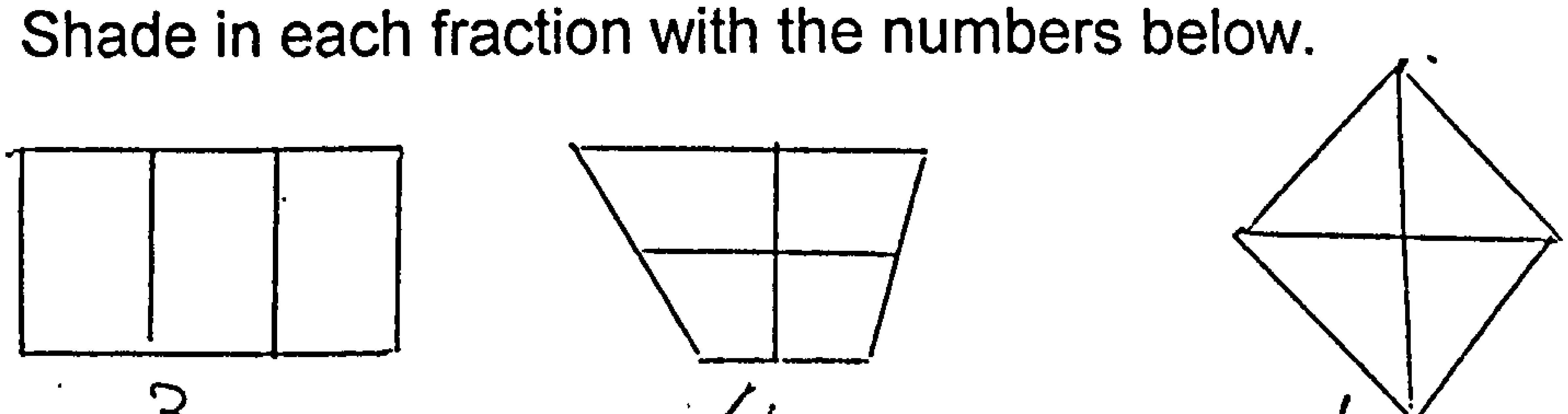


Q3 Where did I go wrong on each fraction? Read below.



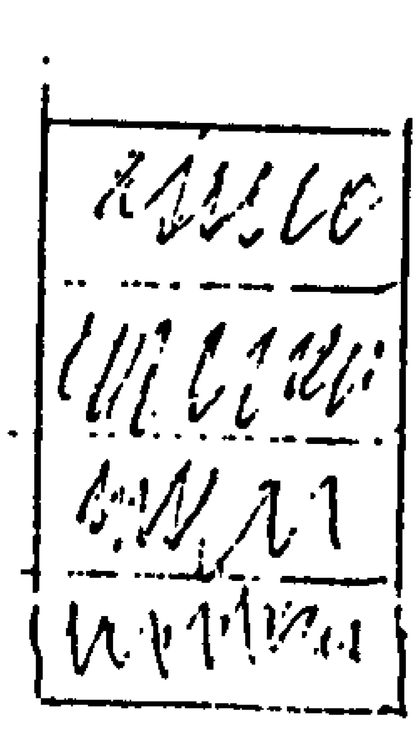
I was asked to shade 4/4 of a fraction.

Q.4 Shade in each fraction with the numbers below.

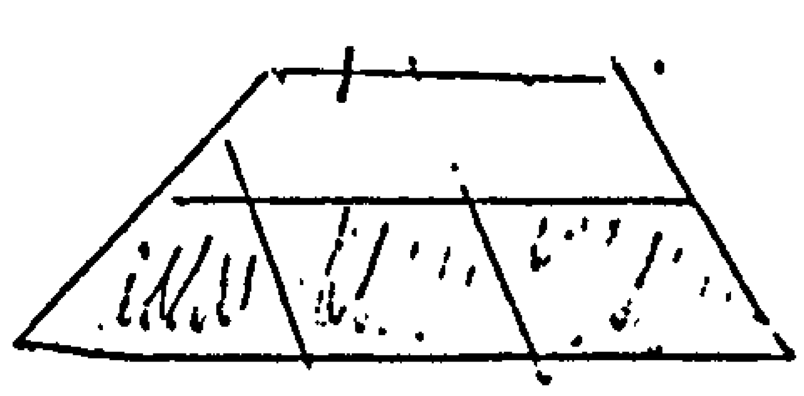


$\frac{3}{3}$ $\frac{4}{4}$ $\frac{1}{4}$

Q.5 Name each right fraction.

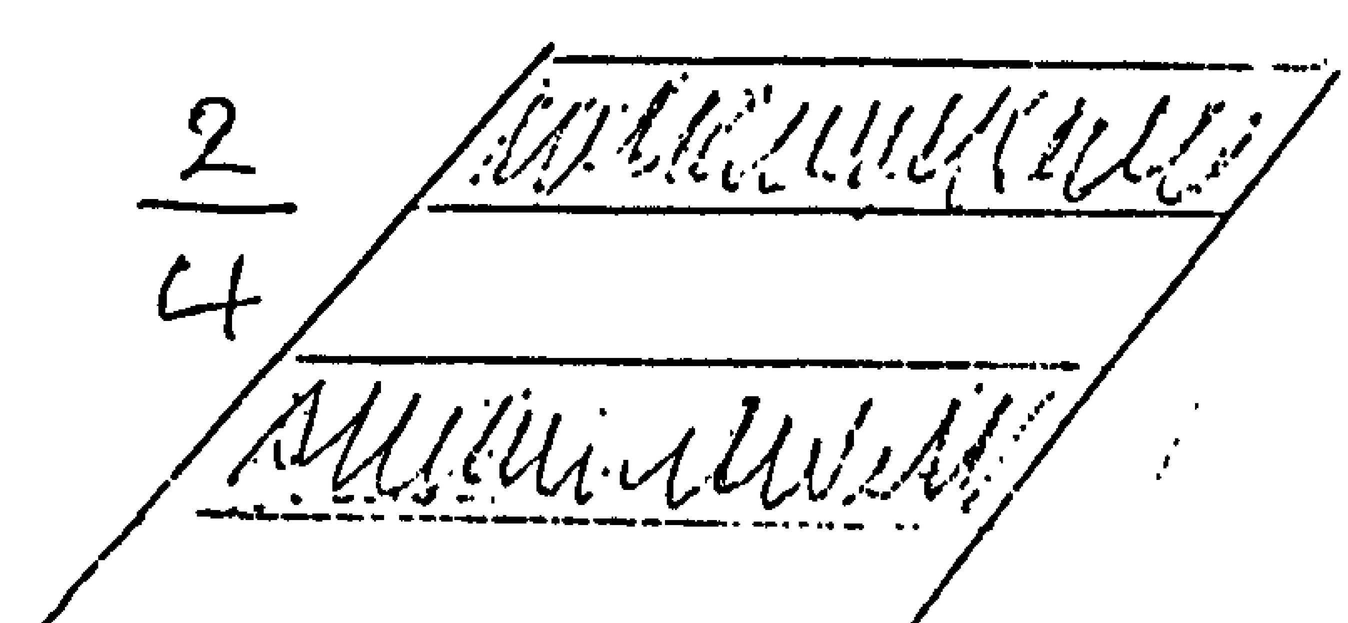


$\frac{5}{4}$



$\frac{3}{6}$

$\frac{2}{4}$



WRITING IN MATHS CLASSES

What I think about writing. It helps you to think of different ideas when you are in the classroom with the teacher. So it could be very difficult if you are a slow learner. The best way is to try and spell all the numbers in words.

I really know if you did go to a very good school and keep it up over the years, If you decided to do a course with experience from that school, depending on the quality of teaching with that teacher you will be good enough to pass the course at a high enough level in the classroom. I really think that as people get older they learn more later on in life. I think that the brain in that person is telling them what to do, to make it sound like sense, and interesting to the teacher.

I do think writing really helps you to concentrate, with the rest of the students not saying nothing. It would be very hard if people are talking at the same time for the teacher to understand what the student in the classroom is saying. I do know if I work very hard on the course that I can show everyone that I can make it on the course. I really do think it is very hard for someone with learning difficulties to pass at a very high level to get the certificate.

Frank

Pascal's Triangle by Violet

Aha! The numbers are doubling.

x 2 each row

Why ?
Conjecture (meaning guess)
If it didn't double you could
get a different shape.

What do I know?
The first one is odd. The
rest are even numbers.

1	1
1 1	2
1 2 1	4
1 3 3 1	8
1 4 6 4 1	16
1 5 10 10 5 1	32
1 6 15 20 15 6 1	64
1 7 21 35 35 21 7 1	128
1 8 28 56 70 56 28 8 1	256
1 9 36 84 126 126 84 36 9 1	512
1 10 45 120 210 252 210 120 45 10 1	1024
1 11 55 165 330 462 462 330 165 55 11 1	2048
1 12 66 220 495 792 924 792 495 220 66 12 1	4096
1 13 78 286 715 1287 1716 1716 1287 715 286 78 13 1	8192
1 14 91 364 1001 2002 3003 3432 3003 2002 1001 364 91 14 1	16384
1 15 105 455 1365 3003 5005 6435 6435 5005 3003 1365 455 105 15 1	32768

Stuck! If stuck you try to specialise.
Work at 4. What do I know about the 4?
The 4 comes from 3 + 1 above it,
then you add it to the 1 next to 4 to get 5.
You add 4 to the 6 next to it, to get 10.
We know where it comes from and where it's going. Where is 4 in this row? Aha?
Aha! You use the numbers twice because they go to each side.

1 1 2
1 2 1 4
1 3 3 1 8
1 4 6 4 1 16
1 5 10 10 5 1 32
1 6 15 20 15 6 1 64
1 7 21 35 35 21 7 1 128
1 8 28 56 70 56 28 8 1 256
1 9 36 84 126 126 84 36 9 1 512
1 10 45 120 210 252 210 120 45 10 1 1024
1 11 55 165 330 462 462 330 165 55 11 1 2048
1 12 66 220 495 792 924 792 495 220 66 12 1 4096
1 13 78 286 715 1287 1716 1716 1287 715 286 78 13 1 8192
1 14 91 364 1001 2002 3003 3432 3003 2002 1001 364 91 14 1 16384
1 15 105 455 1365 3003 5005 6435 6435 5005 3003 1365 455 105 15 1 3316.

Pascal Maths

The circles in the square boxes represent pyramids or triangles.

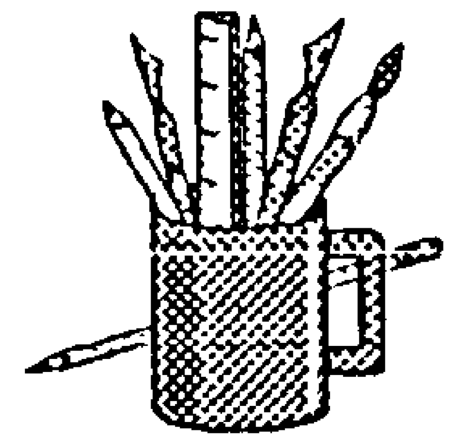
I chose the number 5 to work on and to see how many 5s there are that can go into a certain number in various squares to make the triangle shapes.

Using Pascal shapes it can be in multiplications, divisions or add ups. For example, 5 x 2 = 10 or 5 x 3 = 15 or 5 + 5 = 10 or 5 x 5 = 25, and so on.

The numbers in hand writing have been multiplied by 2 to give you the next number when all the numbers in each row are added up. The circled numbers tell you that the number 5 is multiplied by 2 to give you 10, *or* 10 divided by 2, 10 ÷ 2 = 5 to give you 5.

Violet Kattah

Patterns in Pascal's Triangle



This is the tool You need for Working.

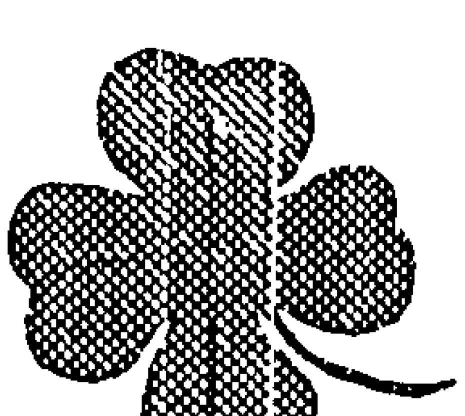
1
1 1
1 2 1
1 3 3 1
1 4 6 4 1
1 5 10 10 5 1
1 6 15 20 15 6 1
1 7 21 35 35 21 7 1
1 8 28 56 70 56 28 8 1
1 9 36 84 126 126 84 36 9 1
1 10 45 120 210 252 210 120 45 10 1
1 11 55 165 330 462 462 330 165 55 11 1
1 12 66 220 495 792 924 792 495 220 66 12 1
1 13 78 286 715 1287 1716 1716 1287 715 286 78 13 1
1 14 91 364 1001 2002 3003 3432 3003 2002 1001 364 91 14 1
1 15 105 455 1365 3003 5005 6435 6435 5005 3003 1365 455 105 15 1

4 X

I think the pattern on the Pascal's Triangle, the one goes down, and you add each number. For example, 1 and 1 is 2, and 2 and 1 is 3.

I have learned a lot from Pascal's Triangle. It helps me with my times table. On my times table, the pattern goes 3, 2, 1, and some fours go two at the top and one at the bottom.

Antoinette Mason



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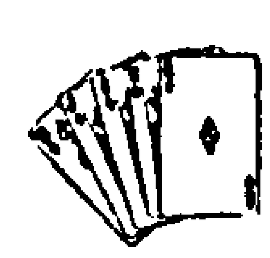


Shazia
On the left hand side and on the right hand side, the number 1 goes from the top all the way down.

The number 2 represents the two 1s in the diamond shapes which are above the 2.

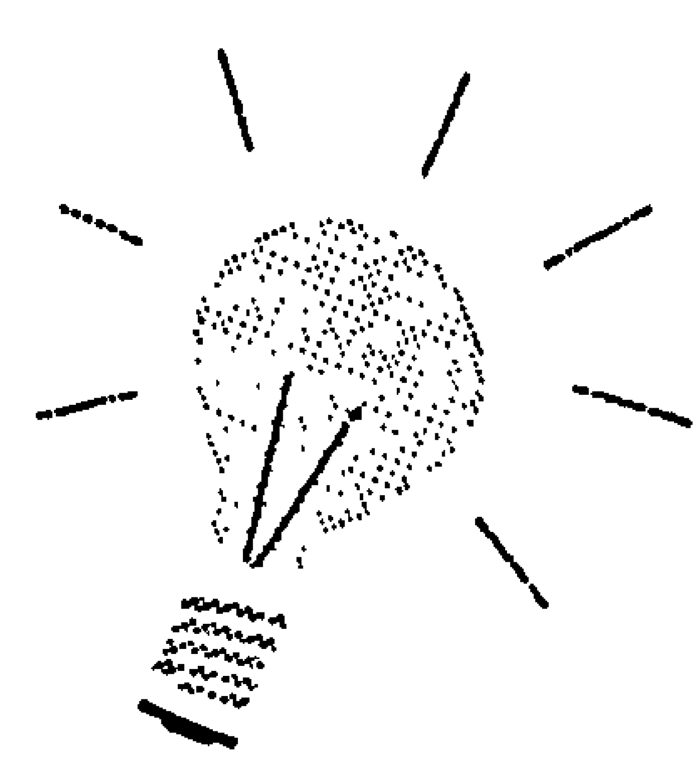
Again the numbers which are at the centre of the triangle, are the answers to the sums which are added from the top and side.

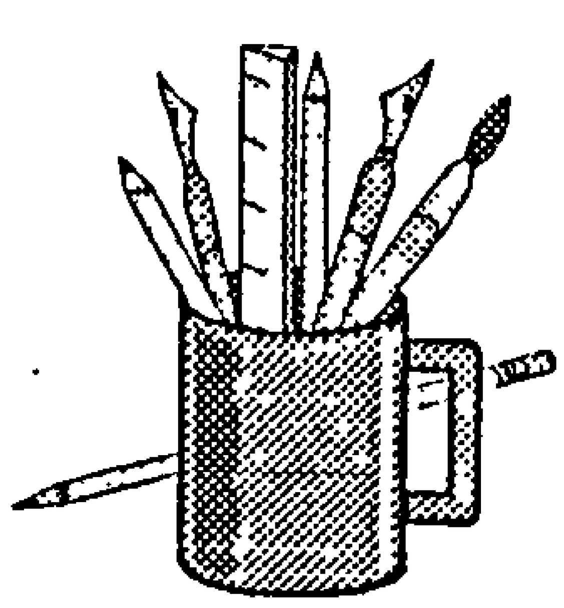
I don't mind doing work on Pascal's Triangle. It makes me look very hard at what I'm doing. This number pattern is very easy, because the numbers are very small, and easy to add up. I think there's more observation than adding up.

Again to me it's like doing symmetry work. I think it's great to do work on symmetry and not thinking it's just maths.

It is difficult to explain in writing but at least when you've written it down, you could always look back at it and you'll know from your own way of thinking, how to pick up where you've left off. People do intend to forget while they're working.

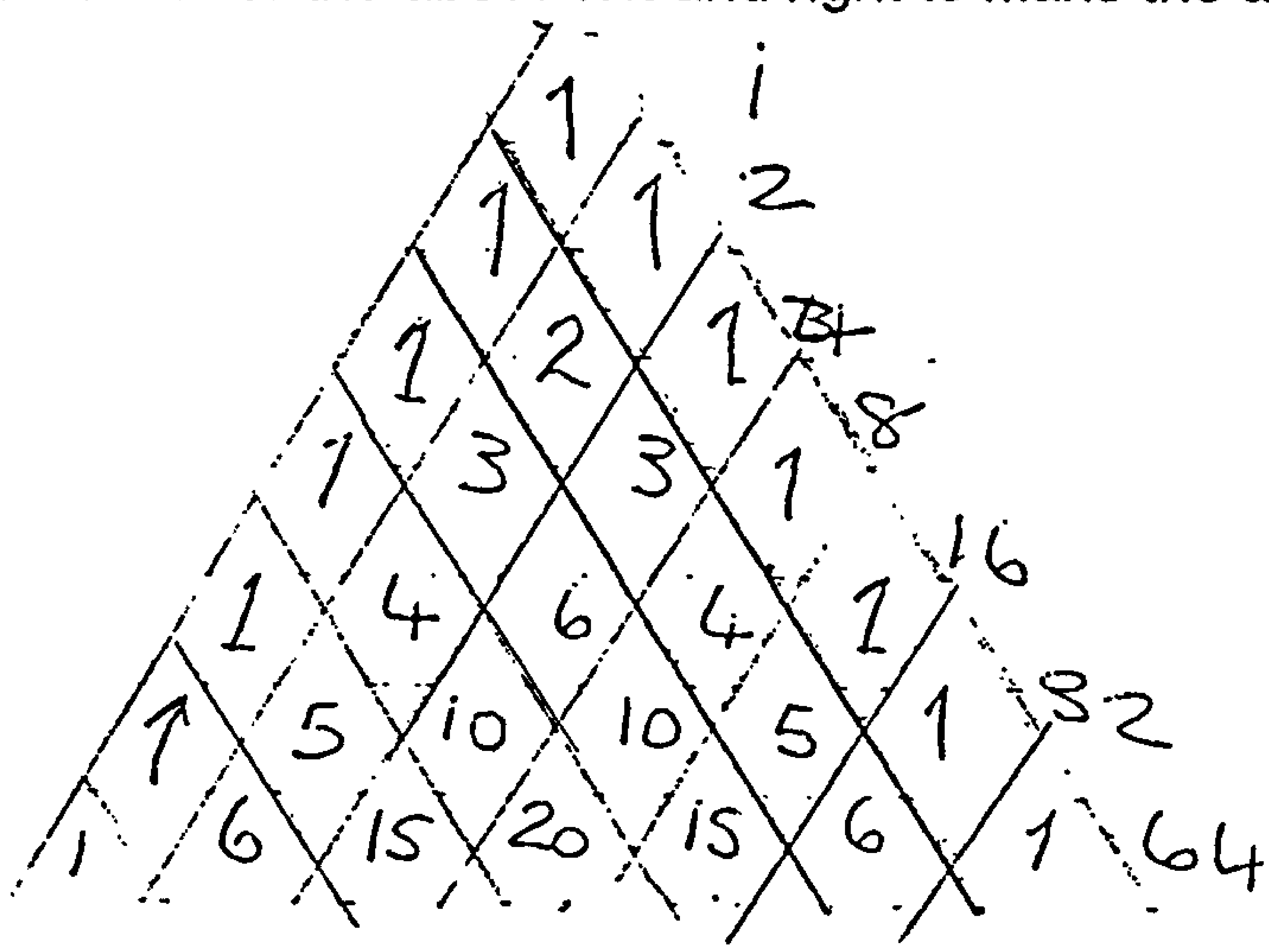
I have learnt quite a bit and enjoyed doing it. I still need more practice, and specially colouring in my number patterns. That way my patterns stand out more clearly.





Lorraine Davies

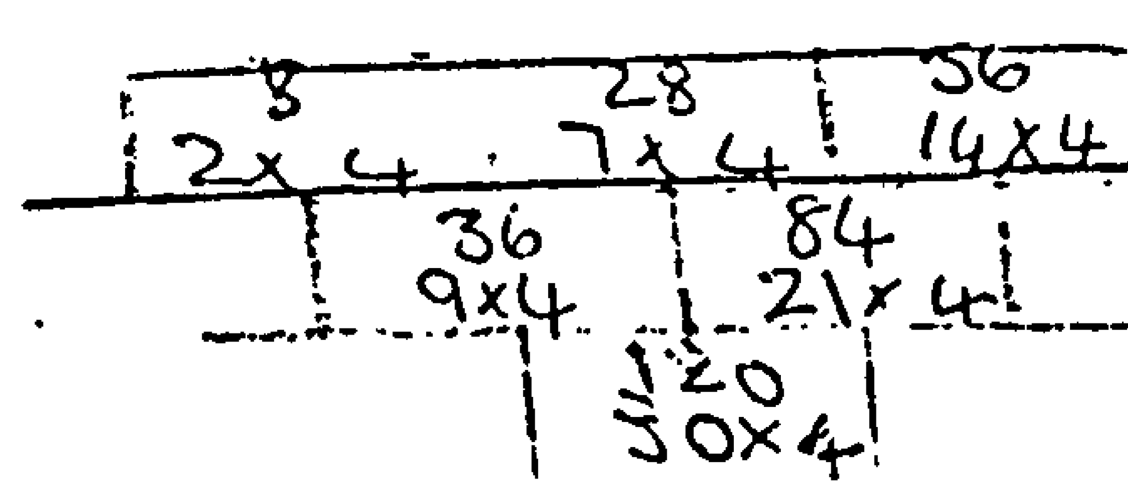
You always have the number 1 on the outsideedges. You start with just 1, then the next line you have two 1s . On the next line you have 1 on the edges with 2 in the middle. You get the 2 by adding the two 1s from the previous line together. This make a triangular shape pattern. You continue adding thetwo numbers to the above left and right to make the answer.



I enjoyed working on Pascal's Triangle. At first I was a bit slow, then it became a lot easier, but you do have to keep checking. I have learned that it has a symmetrical image and that each line across added up, doubles on the next line down.

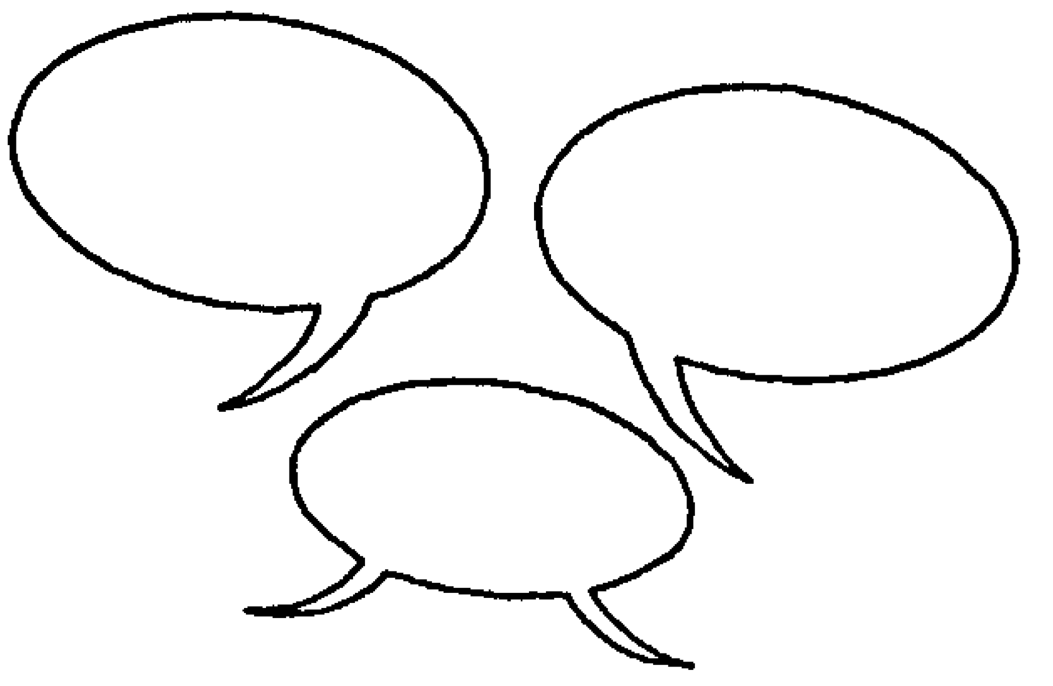
I find it quite hard. I don't know how to start, but once I get going it's quite enjoyable.

Say you have 2 multiples of a number next to each other. When you add them together to make the next row down, it will always be a multiple too. For example



Multiples of 7 in Pascal's Triangle
by Sandra

1
1 1
1 2 1
1 3 3 1
1 4 6 4 1
1 5 10 10 5 1
1 6 15 20 15 6 1
1 7 21 35 35 21 7 1
1 8 28 56 70 56 28 8 1
1 9 36 84 126 126 84 36 9 1
1 10 45 120 210 252 210 120 45 10 1
1 11 55 165 330 462 462 330 165 55 11 1
1 12 66 220 495 792 924 792 495 220 66 12 1
1 13 78 286 715 1287 1716 1716 1287 715 286 78 13 1
1 14 91 364 1001 2002 3003 3432 3003 2002 1001 364 91 14 1
1 15 105 455 1365 3003 5005 6435 6435 5005 3003 1365 455 105 15 1



Talking about maths

In one maths group,
each of the students wrote a review of the term's work,
and then read some of the reviews together.
We made a tape recording
of the reading and discussion.

These are some quotes from the tape.
The people talking are Alev, Dave, Frank, Joyce, Violet
(the students) and Alison (the tutor).

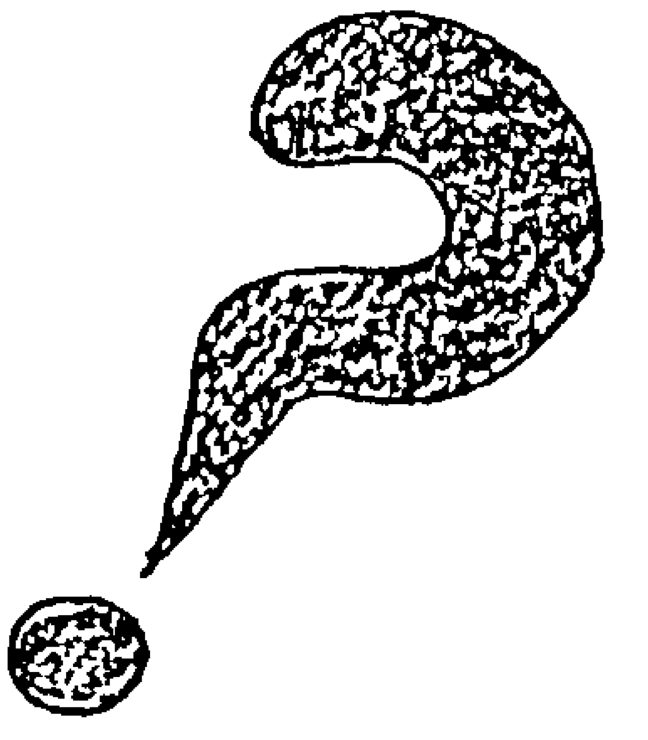
Comments about studying maths

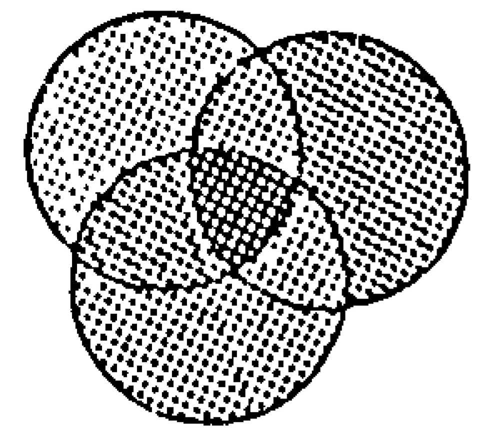
Joyce

When I put it on a piece of paper I cannot see it,
or seem to work it out.
And maybe the next two or three,
I'll go back and find how it's done.
And when I go home tonight I sit there
for about an hour and a half
and I sit and I think,
how the hell I get these?
I use the calculator to do some of them.

How much time do you need for studying maths?
How do you manage homework?

Joyce — I think if we had a little bit more time -
the one hour is not really enough.
By the time I get here, is only one.
Alison — It's very rushed
Dave — I think two hours is alright,
because if you have any more than two hours,
you start getting brain drain.
Violet — I think the hours is alright,
but maybe two times in the week,
because by the time you wait for one week to come,
you literally forget what you've been taught.
Dave — That's the good thing about homework,
isn't it, I suppose.
Violet — We all have a busy life.
One could team up
after the end of the class,
and then two or three people
have to go through everything
on their own free time.
Perhaps what one understand about the course,
the other one can explain,
and we help one another that way.

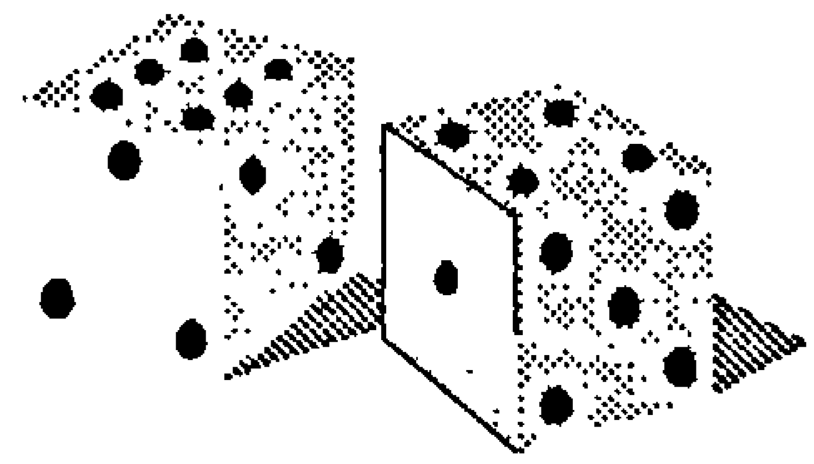




Because when I wrote the history of maths,
after we finished I stop in there in the hall,
and that's how I wrote it,
and I think that's the best thing I have done.

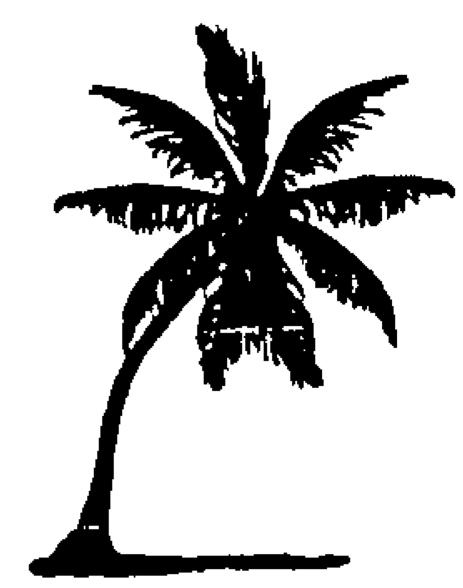
Dave I think what you need is like half an hour,
at the end of the class,
just to get together,
and make sure everyone's understood what they've done.

Alev
I find that hard as well because I've got the kids,
and by the time I've finished with them
and helping them with their homework
I'm just exhausted.
And when I put them to bed,
I just conk out on the settee.
I open a book,
and by the time I read it I'm just tired.



Joyce
But then when the kids go to bed
all I do is sit there, drinking tea and smoking
and doing crosswords.

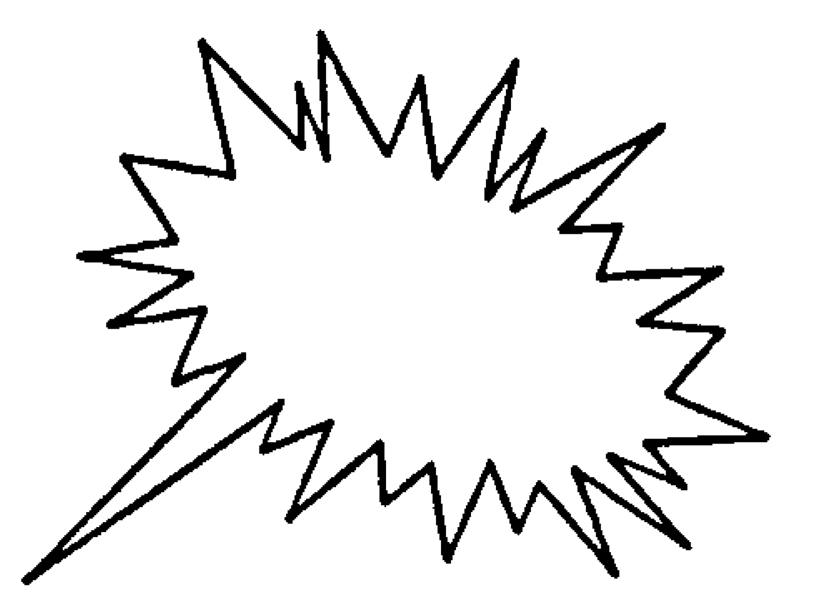
Violet
My worry mostly about this course,
is I don't want to pay the money,
and then I don't get anywhere,
then I look stupid.



Joyce
To be honest, in my case,
I'm the culprit,
I'm the one who's not pulling myself together.

Dave
There must be some time in the week
where you can find an hour or so.

Alev
You know what's good as well is go to the library,
and just read quietly.
That's what I found out,
just sit in there and work quietly.



How hard is it?
How hard do you want it to be?

Frank
I thought there was certain work you had to do,
that's what I thought,
too hard.

Alison
The work you are doing is perfectly difficult enough.
You aren't satisfied,
because you think you don't fully understand it.

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Violet

Some work I feel is even too hard for me.

Alison

What I want is for people to be finding it a little bit difficult.
If you're finding it easy,
well it's a waste of your time.

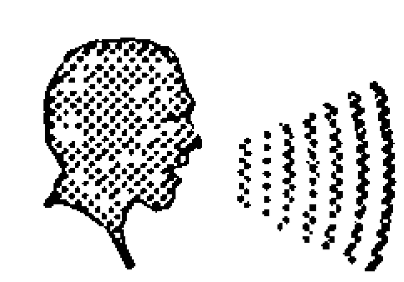
How can the classes be improved?

Frank said in his writing that he finds is hard to concentrate.
This is what Joyce said when she read Frank's writing:

Well, where Frank says,
'It is very hard to concentrate',
I can understand.
What I find personally with him,
he's very good at mental arithmetic.

Dave

Sometimes people get preoccupied
and start talking about different things,
and then you get a bit lost.



Does writing help?

Frank

Yeah, it's good.
When I was writing it out at the time (in the class),
I couldn't explain a lot.
I'm good at writing, and good ideas,
but sometimes I make a mistake on my spelling.

Joyce

If I can't do a thing,
I can't remember,
I'll go back and see what I've written,
how I get to that certain number.

Alev (talking about doing some writing about the class)

I only just joined the class
and I thought I was way behind
and I didn't know what to say
and I didn't know what everybody was doing.

Joyce

I think we all find it helpful,
to trace back,
to go back to our writing things out.
Because sometimes the numbers alone doesn't really help
and in writing we explain ourselves better, I think.
Numbers help
but sometimes we see the numbers
but we can't remember how we get at that number,
so by referring back to the writing,
we find it more helpful.

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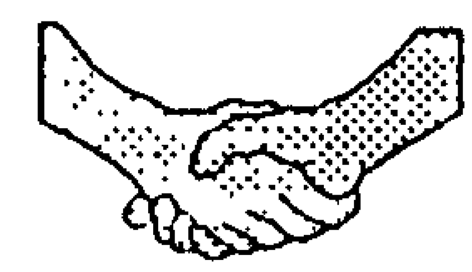
Dave

If you write down what you're not so good at,
you can always keep referring back to that work,
and make it better.

And what about discussion?
Violet

But we discuss it among each other
and then each one bring in his point of view,
how he got to the point.



What kind of worksheet is useful?
The worksheet that started off this writing
did not have many questions.
It had 'starter' sentences instead,
Alison asked whether 'starter' sentences were useful.
People seemed to think they were:
Alev

It's good.

Violet

It helps,
it helps better than maybe asking us
to write about what we have been taught so far,
or our feelings so far from day one up to this point.
We may probably won't be able to know.

Joyce

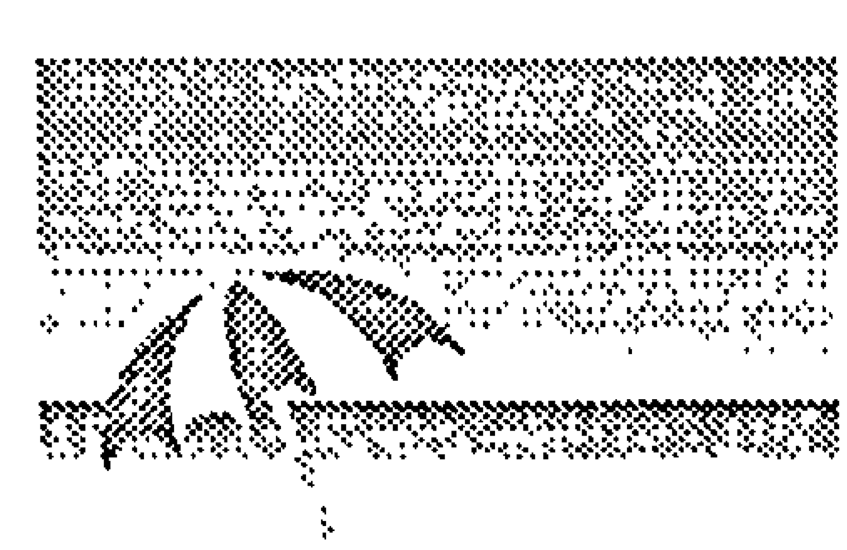
Without it I wouldn't know where to start from.

Dave

It gives you a direction.

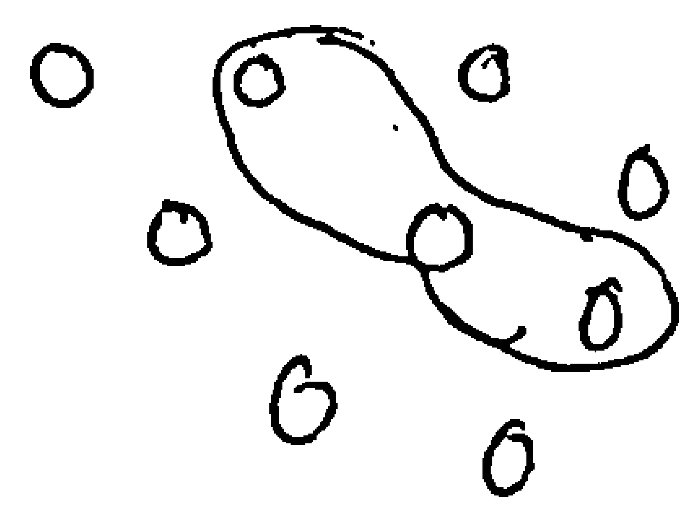
Frank

It gives you a bit of ideas
so you write what you're supposed to write.

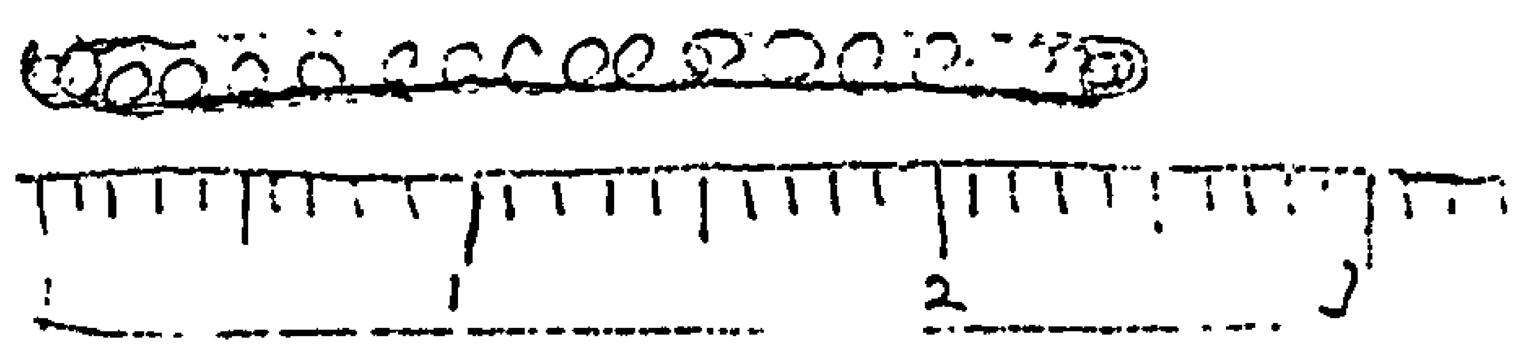


1 Shade in 3/4 of This Square.

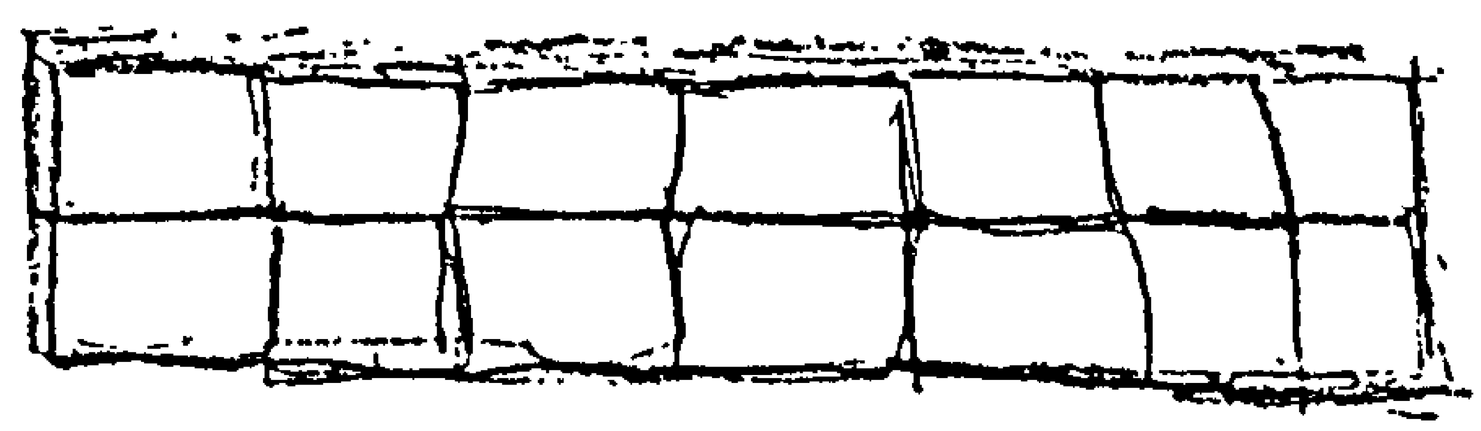
2 Name The Fraction of This



3 Write in The length of The Rope



4 4 Children have a bar of Chocolate between, how will you divide it.

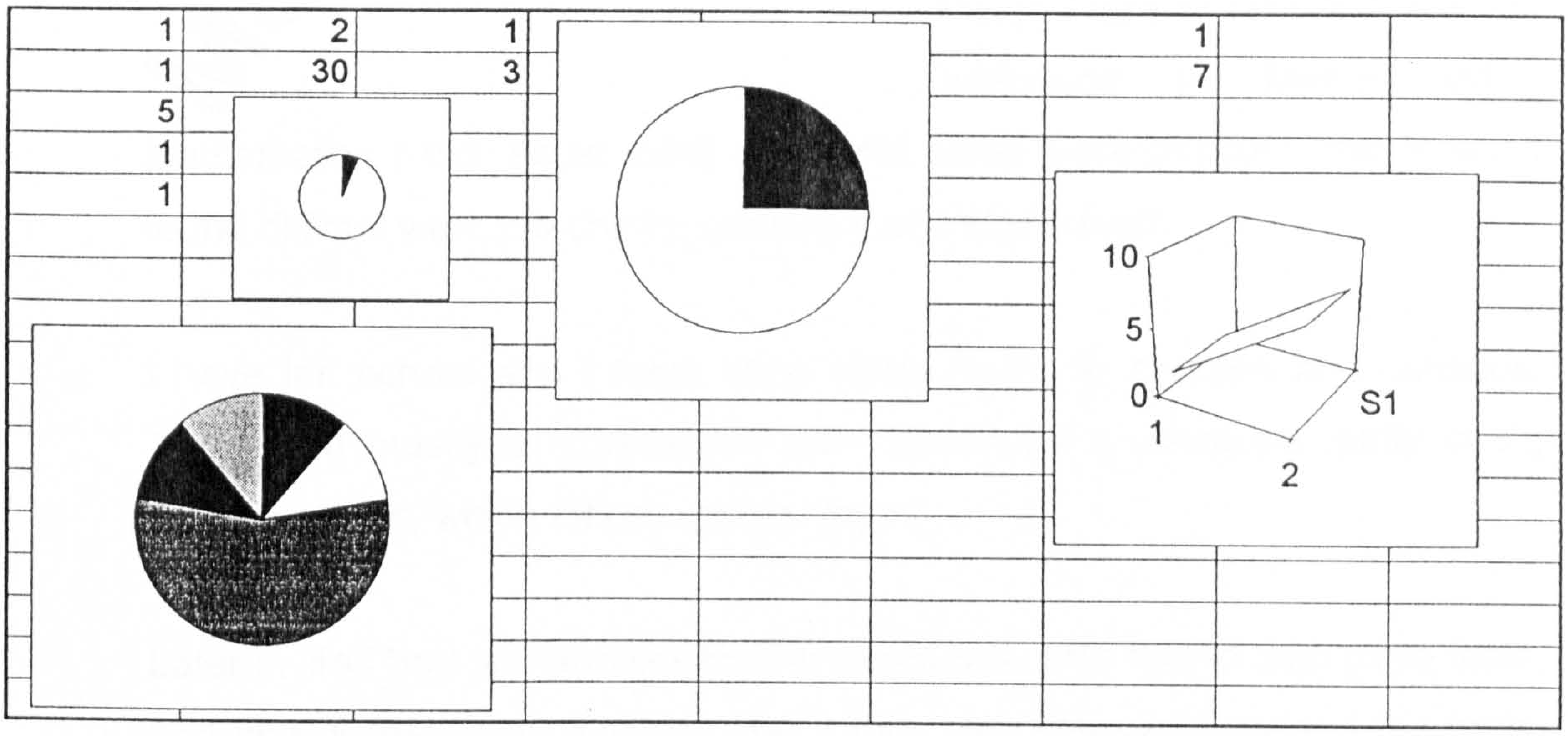


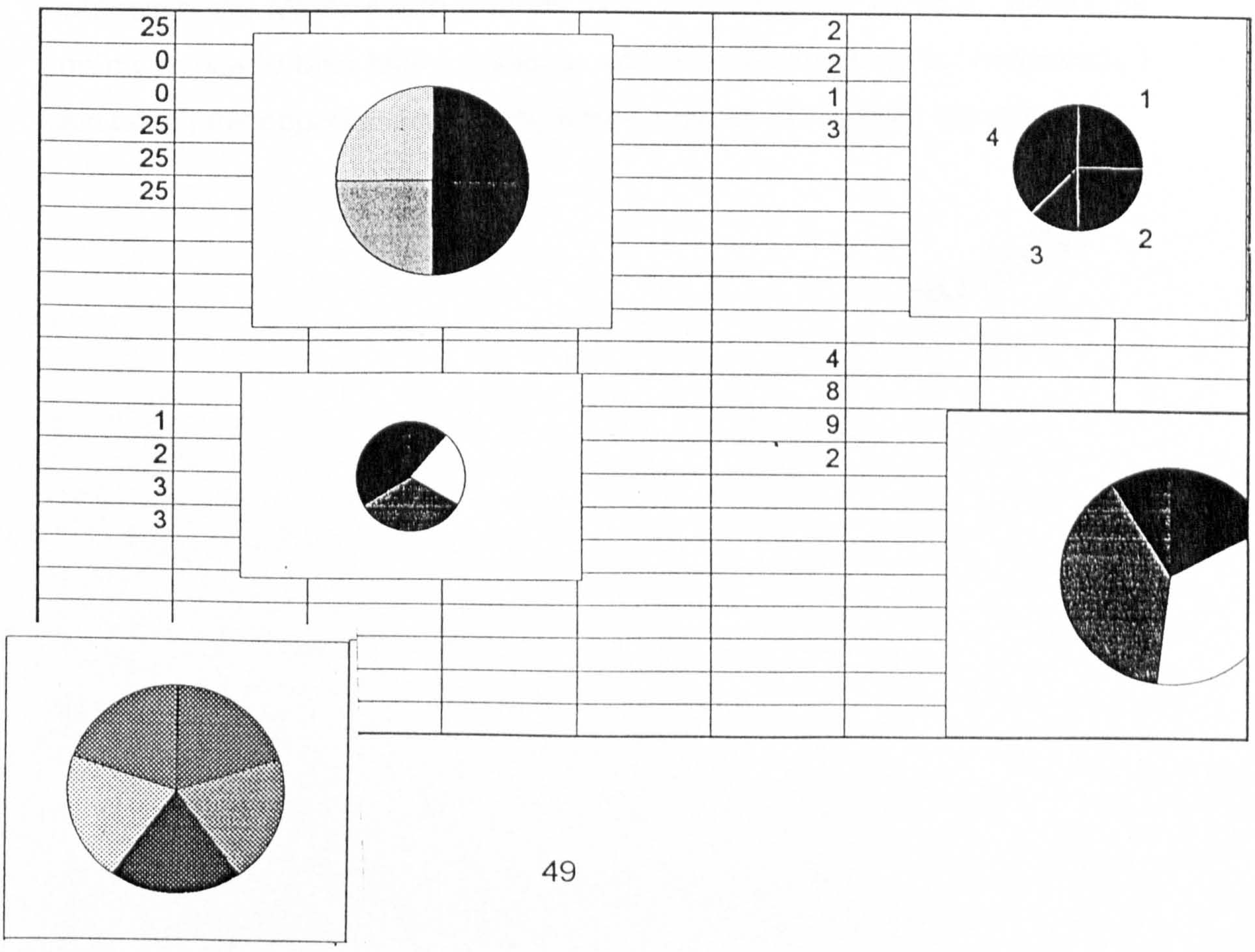
5 You got £400 to share between 12 children how much do you spend on each child?.

Marguerite

WORKING ON EXCEL TO DO FRACTIONS

by SANDRA WILSON





Maths History

When I was at school, I was not interested in Maths. What Mathematics I did, some were easy and some were difficult. The Maths I found difficult were pie charts, geometry and algebra etc.

I have left school and I have done some Maths in courses and colleges. They were mostly in connection with banking, e.g. cheques, petty cash, statements etc, which I thoroughly enjoyed.

Later in life I had an interview for the Royal Mail. We had to take three tests, and one of them was a Maths test. I was very pleased I passed the tests, especially the Maths which was the most difficult of all. As now I have time on my hands to take Maths lessons, and will also find time for homework, I am taking the opportunity in taking Maths classes to highlight my skills.

Novlette

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DIGITAL NUMBERS

If you add the numbers 2468 together you would get what we call the **digital sum.**

EXAMPLE 2+4+6+8=20

But you can take this one procedure one step further to obtain a single digit this is called a **digital root.**

EXAMPLE 2+4+6+8=20

2+0=2

So the digital root of 2468 is 2

Here are some more for you to try. First find the **digital sum.** Then find the **digital root.**

		DIGITAL SUM	DIGITAL ROOT
1)	1,3,5,7,9		
2)	6,8,10,12,14		
3)	10,20,30,40,50		
4)	100,200,300,400,500		
5)	250,350,450,550,650		
6)	1001,3056,755,69,21,		

ANSWERS TO DIGITAL NUMBERS GAME

	DIGITAL SUM	DIGITAL ROOT
1)	25	7
2)	50	5
3)	150	6
4)	1500	6
5)	2250	9
6)	4902	6

Jean Mulholland

Appendix 11: Course evaluation comments

These extracts from students' course evaluation comments were used for group discussion of plans for the following term.

Some comments on the course so far

In planning, I found it difficult,
because I did not know what to start off with.

*I enjoyed doing the lottery chart
because of the discussion we had.*

I didn't enjoy the big numbers and decimals.
I found it very hard.

Enjoyed making my own puzzle.

Found division hard but I'll just keep trying.

I loved drawing times table.

The maths history chart was a surprise.

If possible some harder problems please.

Not too sure about early numbers.
It seemed a bit hard to me.

History of numbers was interesting to know
and adds a new dimension to maths.

I got lost with big numbers.

I learned a lot since I started maths.

*I'm hoping that next term I'm better than this one
and I get on better with my work and practice more.*

*I didn't know what Alison was talking about
until she explained it to me.*

The people in the class are friendly.

I liked the drawing and discussions.

The students are very friendly,
and not snobs.
We can have a good laugh.

The variety of work we have been doing
has been helpful.

The good thing about maths
is the amount of work with others
and having discussions.

How could it be better? .... see over

How could the course be better?

I think that we should do a bit more
on group work.

*At first I found the constant interruption
was taking up too much time,
and I was getting annoyed.*

The classroom could do with some more light in it.

Understanding factors!

Less pie charts and more decimal problems.

More time on pie charts.

Time the following week
to finish off work.

More decimals sums.

Graph work to do with pie charts,